Oal

A

GEOLOGICAL RECONNOISSANCE

OF THE

STATE OF TENNESSEE;

BEING THE AUTHOR'S

First Biennial Report.

PRESENTED TO THE

THIRTY-FIRST GENERAL ASSEMBLY OF TENNESSEE,

DECEMBER, 1855.

BY

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NASHVILLE, TENN.:
G. C. TORBETT & CO., STATE PRINTERS.
1856.

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PRINTED BY A. A. STITT,
SOUTHERN METHODIST PUBLISHING HOUSE, NASHVILLE, TENN.

PREFACE.

For a series of years, previous to the organization of the present Survey, the late Dr. Gerard Troost, a gentleman of high scientific attainments, occupied the position of State Geologist. We had intended to give an outline of the results of his observations, but we are reluctantly compelled to defer it to a future occasion. His reports, however, have been published, and can be referred to if necessary.

In February, 1854, the General Assembly passed an Act creating again "the office of Geologist and Mineralogist of the State," "said office to be filled by the joint vote of both houses of the General Assembly." It was made "the duty of said Geologist and Mineralogist to commence and carry on a geological and mineralogical survey," "with a view to discover the order, relative position, and comparative magnitude of the several strata or geological formations within the State, and to discover, analyze, and assay all beds of deposits of ores, coals, clays, marls, and such other mineral substances as may be deemed useful or valuable, together with such other duties as may be necessary to make a full and complete geological and mineralogical survey;" "and to make a report to the Legislature which shall meet next after his election or appointment, of the progress of such survey, accompanied with such maps, drawings, and specimens as may be necessary," etc.

Soon after the passage of this Act, we were selected to fill the office thus created, and immediately upon the reception of our commission from his Excellency the Governor, entered upon the task assigned us. At the time of our election, we were prosecuting our professional duties in Cumberland University; these, however, being temporarily

placed in the hands of Professor B. C. Jillson, our whole attention has been devoted to the Survey.

Including excursions made during several years previous to our election, the results of which are freely given to the State, we have visited every county, and some of them two or three times. Our object has been to make out first a satisfactory reconnoissance.

The following Report is but an outline of the facts collected and the work accomplished. Our limits have compelled us to postpone for a final report many things which we desired to introduce.

We offer no apology for any defects that may be detected. Our task has been an arduous one, and the means placed at our disposal for prosecuting it very limited. We have been compelled to work without assistance, except where it has been gratuitously afforded us.

We take this occasion to add, with reference to the future, that it is very desirable that at least a small appropriation should be made, to enable us to employ some one to assist and accompany us in our excursions. It would greatly facilitate and hasten the work. We shall, however, in any event, though it may be under difficulties, faithfully carry on the Survey as far as the means given us will justify.

The map which accompanies the Report has cost us much labor. We trust that it will be found both useful and, under the circumstances, satisfactory. Its general features will be found to be correct, though we by no means present it as a perfect or final Geological Map of Tennessee; this would imply the completion of the Survey. Hereafter, in other editions, we shall aim to add to it, make such changes as may be found necessary, and in every way render it more complete and worthy of the rich geological and mineralogical field we occupy.

We are under especial obligations to Dr. C. A. Proctor, State Assayer, for data used in the construction of the Map of the Copper Mines. Mr. T. H. Callaway assisted us also in making out the probable continuity and range of the veins; the courses, etc., given, must however, for the present, be taken as approximations.

Our thanks are due to Professors B. C. Jillson and A. H. Buchanan, of Cumberland University, as well as to Mr. D. Cook, Jr., of Lebanon,

for assistance rendered in the construction of the map. To Prof. Jillson we are, in addition, under great obligations for kindly accompanying and assisting us during a long excursion through East Tennessee.

The wood-cuts in the Report were executed by H. Bosse, a skilful artist of Nashville.

In conclusion, it affords us much pleasure to acknowledge the hospitality that we have universally met with, and often the valuable assistance that we have received from our fellow-citizens throughout the State. We hesitate to mention names, for fear we may omit some whose kind attentions we have experienced. We must be permitted, however, to acknowledge the kindness of the following gentlemen, in addition to those of whom we have spoken in the body of the Report; for especial favors our thanks are due to Mr. William Allen, of Smith, Col. Wheeler and Mr. Robert Morrow, of Campbell, many gentlemen of Knox, Gen. Sam Millegan, of Greene, Dr. John P. Chester, Hon. John Blair, Messrs. A. J. and R. L. Blair, Dr. A. N. Harris, Mr. C. Meek, and Mr. I. Murray, of Washington, C. W. Nelson, Esq., the Messrs. Carter, Messrs. L. W. Hampton and Elijah Simerley, of Carter, Mr. G. Moore, of Taylorsville, several gentlemen of Sevierville, Dr. Gillespie, of Maryville, Col. Asa Watson, of Montvale, Messrs. Welch and Harris, of Tellico, Dr. W. W. Morris, of Jasper, Mr. McNealy and Dr. J. M. Larkins, of Charlotte, Dr. E. B. Haskins, President W. M. Stewart, and other gentlemen of Clarksville, Senator A. P. Hall, of Benton, Dr. John S. Pearson and other gentlemen of Memphis, Professor H. A. Gwyn, of Hardeman, Mr. Thomas Combs, of McNairy, etc. Most of these gentlemen accompanied us on local excursions, travelling with us often twenty, thirty, and even sixty miles.

To all our iron-masters with whom we came in contact, we are much indebted for valuable information, and for the characteristic hospitality we always met with at their hands. There are many others from whom we received favors, and to whom we are deeply grateful.

J. M. SAFFORD.

LEBANON, Tenn.,
February 1st, 1856.

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A

GEOLOGICAL RECONNOISSANCE

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CHAPTER I.

INTRODUCTORY.—THE GEOLOGICAL SURVEY.

1. *Its objects and utility.*—As some of our friends may be uninformed in regard to the nature of the survey, we think, perhaps, it will be acceptable to give, at the outset, an outline of the objects proposed, and the practical benefits aimed at. We have, therefore, specified several considerations, to which we invite attention. Among them, the two following are eminently practical and important, and are leading objects in the survey.

First. The development and the elucidation of the mineral wealth of the State.

Secondly. The development of the agricultural resources of the State; the thorough examination and classification of its soils, with reference to their improvement and greatest production.

2. In regard to the first, the great points are: to discover and develop mineral resources, that are, as yet, *unknown;* to trace out, through their length and breadth, valuable beds, strata, and veins of all sorts, now, in many cases, *known only at single points*, and thus to extend the resources of these single points over a long line of country,

reaching, it may be, through half a dozen counties;—for example, starting from an isolated opening of *coal*, or *marble*, or *galena*, or *iron-ore*, to trace the *stratum* or *vein* that affords it, through its entire extent, and thus to lay the way for a long line of such openings.

3. Another point is, to indicate the best methods for making practically available all these geological and mineral products in contributing to the interests of our citizens, and the wealth of the State; this we do, by pointing out sites suitable for furnaces and forges, localities favorable for economic mining, points for the opening of coal-banks, of millstone and marble quarries; by indicating the utility and market value of this product, and the mode of using that; by determining the relative worth and the qualities of the different coals, ores, mineral manures, building materials, etc., through the means of chemical analyses and experiments, thus enabling us to select the best, and to assign each to its specific use.

All these the survey has done, and is capable of doing far more extensively.

4. Another collateral and important point is, to make out and present, in a satisfactory form, a full account of what we already know and are doing with reference to our mineral wealth, in order, thereby, that capitalists, abroad and at home, may become informed and assured of its real value.

Statistical information has a great influence, not only upon the credit of the State, but in giving direction to capital unemployed and seeking investment. Such information is a great index, marking the road to the regions that promise most.

How is it with reference to Tennessee? Are her columns in the mineral statistical tables of the country a fair representation of her actual resources, or are they vague and worthless? Let us see.

5. The author of the only standard work on the coal and coal-trade of the United States,* complains greatly of the meagre statistical information he has with reference to Tennessee, and excuses his short

* Statistics of Coal. By R. C. Taylor. Second edition: revised, and brought down to 1854, by Prof. S. S. Haldeman.

notice by saying that, "It is evident that much remains to be done in Tennessee, in the way of geological elucidation, and the development of the coal and iron of the State."

We met lately with an article from a distant State, in which the author thought it necessary to prove laboriously—as if there could be doubt about it—that coal does really occur in our Cumberland table-land, which "will pay" to work!

These are not isolated examples. Books and papers on the metallic wealth,* and the mineral productions of the country generally, pass us by, or give us, at most, a humiliating notice.

6. Now what is the effect of all this? Most surely, to throw a damper upon the prospects of those who turn their attention to Tennessee—to keep, perhaps to drive, enterprise and capital out of the State—to permit the resources of other regions, not as promising but better known, to attract the money and men seeking employment. If the survey, then, should do nothing more than to place our productive mineral wealth, by means of statistical tables, etc., in the proper light before the world, it will be of great service to the State.

7. But, again, in regard to our *agricultural resources*. To know what our soils consist of; what they lack; how they can be improved; how many varieties they present; to what each is best adapted; and how we can attain to their maximum production, are certainly points of great interest. To determine these is among the objects proposed.

But, it may be asked, how are these connected with the Geological Survey? We will endeavor to show.

The soil may, properly, be regarded as a geological product; for it is generally the result of the disintegration or crumbling of the rock or formation upon which it rests, and always varies, more or less, as this varies. Hence we have limestone, sandstone, slate, and granite soils. The connection is even more intimate than this: the soil of limestone, for instance, varies with the impurities of the limestone, and

* See, especially, Whitney's elegant and valuable work on the Metallic Wealth of the United States, p. 475.

may be mellow or stiff, sandy or argillaceous, red or yellow, according to these impurities.

Now, did we but know the characters, range, and extent of each of the geological formations, or, in other words, of each of the great rocky layers, the outcrops of which make up, something like mosaic-work, the surface of the State, the labor would be, at least, half done toward the systematic investigation and classification of our soils.

8. To illustrate, we will briefly refer to the limestones and soils of central Middle Tennessee. These limestones, differing in the kind and relative quantity of the impurities they contain, such as sand, clay, oxide of iron, etc., can be easily separated into at least three distinct groups, one after the other forming the surface rock. Ranges of these are passed over in going from Murfreesboro' to Nashville. Each one affords, coëxtensive with itself, a specific soil: the reddish chocolate cotton lands about Murfreesboro' are characteristic of one group; the thin soil of the cedar glades, which surround the last in a great circle, mark the range of another; the mellow "mulatto" and excellent lands of the greater part of Davidson, that of the third—all differing, as the rocks upon which they rest differ. In each case, a knowledge of the characters of the limestone enables us to anticipate the characters of the soil, and to account for its peculiarities.

Such, in general, being the connection, it is easy to see how the Geological Survey will contribute to a knowledge of our soils—in fact, how it affords the only practicable basis for a systematic description of them. The general characters, together with the range and extent of each kind, having been made out by the survey, it will be a comparatively easy task, by means of practical experiments, observations, etc., to complete the work. So much for the leading objects of the survey.

9. We will add three other important considerations.

First. While it is essential to know what useful products particular regions can furnish, it is, in many cases, equally as essential to know what they cannot furnish; for, otherwise, capital and a laudable enterprise may take the wrong direction. In fact, there has been, in Tennessee, enough time, money, and labor squandered in searching for

"metals," coal, etc., in places where they cannot possibly be found, to pay for half a dozen practical geological surveys. Such operations would continue, without a survey, to the end of time.

We will give but one example out of very many known to us. There is, in Middle Tennessee, a great layer of *black slate*, occurring, more or less, in every county. This slate—simply because it is *slate*, and *black*—has been dug into for stone-coal in at least two hundred places. It is, in fact, no more indicative of coal, in the position it occupies, than is the blue limestone below it. The labor and money thus expended have all been thrown away. The proper statement of the geological relations of this formation would have prevented it, and, what is more, it would have made known, to those interested, a real product, which it can be made to afford, and upon which their enterprise might have been profitably expended. I allude to *alum*, for the manufacture of which this slate, in many places, is well adapted.

Other examples of like nature will occur, no doubt, to many of my readers within the range of their own observation, and perhaps experience. We have enough of real value in Tennessee for the employment of our capital and enterprise, without wasting them in misdirected speculations.

The practical utility of the survey, in this matter, must be apparent.

10. *Secondly*. There is a large class of our citizens who are interested in geology as a science. Their claims must not be overlooked. All our colleges, seminaries, and schools of any pretensions, teach it. The geology they teach, however, *borrows* its illustrations and facts from abroad—the results of the labors of others mostly in foreign countries. It thus loses half its interest, and half its practical value. This necessity is humiliating, especially as we have around us a most fertile field, a vast treasury, almost unopened, of facts unsurpassed in interest, and highly illustrative of the principles of the science.

Let us open this treasury—let us make the geological phenomena of Tennessee accessible to the teacher, so that he may draw his illustrations from the rocks, the minerals, the mines, the fossils, etc., around him, and thus bring the subject home to his pupils.

11. *Finally.* In thus securing all these practical objects, we have besides the pleasure to know that we are contributing our mite to the cause of general science. In this day of telegraphs, of steam and electricity, of railroads and steamships, it would be ungrateful to overlook her claims. She is the basis of a thousand arts, and the prime agent in the perfection of a thousand more. All that is contributed to her will be repaid a hundred-fold.

12. *Plan and progress of the survey.*—The plan pursued has been, first, to make out a General Survey or Reconnoissance of the whole State. In fact, the wishes of our citizens required this course, and left us no alternative. Nothing, however, has been lost, for it is, perhaps, the most efficient method that could have been adopted. It gives an outline of the geological character and mineral products of the whole field; enables us to designate points of especial interest, and such as are worthy of a detailed examination; makes known the characters common to distinct regions, and thus uniting them, shortens the work. It lays before the geologist his entire field, determines his routes, economizes his time, and, in all respects, clears the way for the successful and rapid prosecution of what follows next in order, a detailed survey.

13. In carrying out the reconnoissance, the first consideration has been to trace out the great *geological formations;** for these constitute, as we have already said in regard to the soils, the basis of all future operations, and without them there can be no systematic survey; they are the *great storehouses*, each of which contains its own mineral *treasures;* nor need we think of easily securing these treasures, complete and entire, without a knowledge of the position and extent of their great repositories.

This part of the survey has, *in a general way*, been accomplished. The formations, with but few exceptions, from the Mississippi River to the North Carolina line, have been traced out, and their general range and limits ascertained and given upon the map accompanying the

* For the meaning we attach to *formation*, see Chapter V.

report. In the sixth chapter they are enumerated, and their characters and products noticed.

14. Another consideration has been, while at work in the field, to make out, as far as time would permit, the useful *mineral contents* of each formation. This, as we have already intimated, is the second step in our progress, and properly follows the making out of the formations. It must become the leading feature in the survey.

Much already has been done. Dr. Troost's researches, although he never had the means to give them that scope and utility desirable, have nevertheless accomplished much toward this end; and, by the way, we could easily now point out how his labors *have already paid the State, in actual capital, three-fold more than they cost it.*

Again, the enterprise of many of our fellow-citizens has contributed largely to a knowledge of our mineral wealth. We would be pleased to enumerate the contributions of each one, and shall do so as far as it is in our power.

Finally, our own labors in this matter have, we trust, not been fruitless. The pleasure has often been afforded us of pointing out valuable beds, minerals, etc., before *unknown*, and of calling attention to other useful products hitherto little regarded. These will be spoken of hereafter. In the third and fourth chapters we have endeavored to give, among other things, a general account of what has been accomplished for this feature of the survey.

15. Attention also has been given, in a general way, to *agricultural characters*, and the description of each formation will be followed by a notice of its soil. This feature of our work is perhaps equal to the last in importance. Much remains to be done in this interesting field; in fact, we have but just entered it. We desire to have it in our power to analyze a great number of soils, and to institute a series of experiments upon certain mineral manures found within the State. Hitherto our constant labor in the field has not allowed us much time for systematic analyses.

16. We have also made it a point, in our travels over the State, to gather all the *statistical information* we could in regard to our mineral

production. The results are given in chapters third and fourth, and I trust may prove acceptable, at least as far as they go.

Finally, in the midst of our regular labors, we have at all times endeavored to accommodate our fellow-citizens as far as possible, by visiting localities of real or imaginary interest, and by testing and analyzing the specimens brought to us, hundreds of which we have examined.

CHAPTER II.

INTRODUCTORY.—THE GREAT NATURAL DIVISIONS OF TENNESSEE.

17. *The seven divisions.**—As it will frequently be necessary to refer, specifically, to those great regions of the State, each of which has physical characters of its own, we think it best, before proceeding farther, to enumerate and describe them. They are peculiarly distinct, not only topographically, but with reference to their rocks, minerals, and soils. Upon them are based, in part, the three political divisions of East, Middle, and West Tennessee. The following notices will relate mostly to their extent, limits, relief, and general aspects, with occasional references to their soils and agricultural features. We enumerate seven of them. The first three, running through the eastern part of the State, belong to the great Alleghany or Appalachian system of mountains and valleys. Commencing with the most eastern, they are as follows:

1*st.* *The Unaka Bed of Mountains;*
2*d.* *The Valley of East Tennessee;*
3*d.* *The Cumberland Table-land;*
4*th.* *The Highland Rim of Middle Tennessee*, encircling
5*th.* *The Central Limestone Basin;*
6*th.* *The Slopes of West Tennessee;* and
7*th.* *The Mississippi Bottoms.*

18. 1*st.* *The Unaka Bed of Mountains.*—This name we give to the whole group of great and wild mountain ridges which run through the

* See also, in connection with this chapter, the map and the section at its base.

State along its eastern boundary, and which occupy a strip of its area, *on an average*, about eight or ten miles wide. The highest of these constitute, for the most part, the line separating us from North Carolina.

This great bed is cut through by the Watauga, the Nolichucky, the French Broad, the Big Pigeon, the Tennessee, the Hiwassee and Ocoee. These rivers, in their courses from the western slopes of the Blue Ridge, in North Carolina and Georgia, break through in narrow, deep, and, in some cases, almost inaccessible gorges, within which their waters are tossed, in rapids, over the rocks for miles.

The water-power afforded by these streams, as they issue from among the mountains, is immense, and at numerous points available. East Tennessee has much to gain from the effective natural power thus given her.

19. Many of the mountain ridges are continuous for long distances, while others are short and interrupted. The greatest local bed—called the Great Smoky—occurs along the line in Cocke, Sevier, and Blount. In Washington and Carter, there is another series nearly as great and even greater in altitude, including the lofty and beautiful mountains, the Bald and the Roan. All along, from Virginia to Georgia, the great ridges trend to the south-east and north-west, marshalling themselves in parallel or nearly parallel ranges, occasionally united by great arms, which run across. Sometimes, however, oblique to the general direction, they converge, run up, and culminate in some lofty peak. Many interrupted outlying ranges, such as the Stone, in Carter, the Buffalo, the Meadow Creek, the Chilhowee, and Star's Mountains, start up suddenly, just within the edge of the valley below, and cut off long, narrow *coves*, overlooked on both sides by mountains, and rich in iron ores.

20. Occasionally, we find the ridges exceedingly rough, and spread over with heavy evergreen thickets, but more frequently covered with open woods, through which it is not difficult to ride for miles. On many of them the soil affords a fine growth, and an abundance of wild grass and vines, upon which droves of stock are kept and fattened.

These, at present, wild regions are well suited for excellent highland pasture-grounds, and ought, some day, to be covered with cultivated grasses.

The height of these mountains is from two thousand to six thousand feet. Many of the highest points are destitute of trees, but, prairie-like, abound in ferns and wild grass. Such points are called "bald places," or simply the "balds." We have seen them, in the summer season, alive with stock of all kinds, literally feeding and fattening among the clouds.

21. The views obtained from these "balds," when the sky is cloudless, are really magnificent. Eastward a vast bed of mountains appears; but westward the valley of East Tennessee far below can be seen, spreading out like a rich and variegated carpet; its rolling surface becomes a plain, spotted all over with evidences of activity and life. When, at first, we turn from the wild peaks immediately around, it indeed looks like a "land of promise." From some of these points the eye reaches entirely across the valley. The table-land of the Cumberland can be seen, far to the west, rising up dimly, and terminating the view.

The geological structure and mineral products of the Unaka group will be spoken of hereafter.

22. *2d. The Valley of East Tennessee.*—This populous and beautiful portion of the State is flanked on the south-east by the great bed of mountains just spoken of, and on the north-west and west by the Cumberland table-land. The valley is thus limited and overlooked on both sides by mountains; but opens out north-eastward into Virginia, and south-westward into Georgia—widening as it approaches the former, but narrowed as it enters the latter.

It is mostly a great group of small troughs, or narrow straight valleys, separated by long parallel ridges, all trending, as a general thing, to the north-east and south-west. This parallelism of ridges and valleys is one of the characteristics of East Tennessee, and results entirely from its geological structure. Owing to it the surface of the country is often rolling. "Across the country" is here a very signifi-

cant phrase. The luckless traveller whose route lies in that direction understands it, and, unless happily favored with breaks and "gaps" in the ridges, prepares for

"Wave on wave succeeding!"

On the other hand, "up" or "down" the country is as equally significant of good level roads, and enables the tardy driver "to make time."

23. We cannot here enumerate the numerous valleys that this Division includes. Many of them are noted for their great beauty and fertility. There are several, more or less cut off from the main group by arms and outliers of the Cumberland and Unaka, which, in all their physical characters, belong to this Division. Such are the interesting valley of Sequatchee, that of the Elk Fork, and the coves (§ 19) included in the mountain ranges of the Unaka.

24. The valley ridges are important features in the topography of the country. Some of them, steep and roof-like, run for more than a hundred miles in a straight or gently curving line. Several are entitled to the name of mountains. In the northern part of the State, especially, there are three groups, which ought to be mentioned.

First, the *Bay's Mountain group*, an interesting bed of half a dozen parallel, straight and crowded ridges, lying mostly in and between the counties of Jefferson and Hawkins on the one hand, and Sullivan and Greene on the other.* This is exclusively a Tennessee series.

Secondly, the *Clinch group*, including, together with the Clinch Mountain, the parallel ranges known as the Stone and Pine Mountains, and an outlier, the Devil's Nose.

Lastly, the *Powell's Mountain group*, a series of three great ridges, also parallel, Wallin's, Powell's, and Newman's, which start up in Claiborne, and run through Hancock into Virginia.

In the southern part of the State, *White Oak Mountain*, with its allied ranges, is conspicuous, and belongs to the valley.

* We do not include the so-called Bay's Mountain in the lower part of Jefferson and in Sevier. These ridges belong to an entirely different range of rocks.

Lookout and Raccoon Mountains are referred to the Cumberland table-land, being identical with it in all their physical characters.

25. The *soils and agricultural features* of the valley of East Tennessee, like its rocks, are remarkably various. It is difficult to predicate any thing in general with reference to them. The numerous and delightful limestone valleys excel in fertility. The ridges present various characters. In many cases, one side of a ridge, for many miles in succession, may be seen covered with beautiful fields and luxuriant grain up to the very top; while the other, all rock or sand, is worth but little more than the firewood upon it. There are extensive strips of country, which do not partake so much of the ridge and valley character, that afford beautiful rolling farms and soils of excellent quality.

But we cannot here enlarge. It is to a *final* description of the specific rocky formations that we must look for the foundation of a classified account of these soils.

26. 3*d*. *The Cumberland Table-land.*—This includes the so-called Cumberland Mountain or mountains. It is truly a table-land, its sides being well defined by steep escarpments. To us it possesses great interest, being our portion of the great Alleghany coal-field. At some points it is forty miles wide, and, altogether, covers an area of four thousand four hundred square miles—one-tenth of the State. Running obliquely across the State, it could furnish a highway from Kentucky to Alabama upon its sandstone top. Though comparatively flat, it does not become monotonous to the traveller. Low ridges and shallow valleys, with crystal streams, are occasionally met with, and afford a pleasant variety, which relieves what would otherwise be the sameness of its "flat woods."

27. In Bledsoe, Morgan, Anderson, Scott, and Campbell, we have some local and peculiar features—mountains, in fact, upon the table-land. The waters of the Emery and New Rivers, especially, flow from a bed of mountains which rise massively above the general level, and which are conspicuous objects to the hunter many miles to the west. When seen from the east, they cannot be separated from the table-

land. They blend and run down with it to the valley. It is here that the highest peaks of the Cumberland occur, and they are to be seen from all the high points in the northern part of the valley of East Tennessee.

The agricultural capacities of these mountains are better than those of the Cumberland generally. Beautiful groves of walnut, hickory, sugar-tree, poplar, etc., are not unfrequent upon them. At many points the lands are strong, rich, and valuable.

South of the Emery, another mountain or ridge—the Crab Orchard—rises nearly a thousand feet above the general level. This, with other high points, and a singular depression, called the "Grassy Cove," are in a line with Sequatchee Valley.

28. In looking over the map of the table-land, its eastern limit is seen to be a nearly straight or gently curving line: the indentations made by the streams are hardly noticeable.

Along its western limit, however, it is very different. Here it is cut by numerous deep bays, flanked by branching promontories, which jut out to the west, overlooking the great flat Rim of Middle Tennessee, hereafter to be spoken of. These deep indentations, through which flow, on their way from the table-land, the different branches of the Elk, the Caney Fork, and Obey's River, give the western outline a remarkably ragged and dissected appearance.

29. The greater part of the eastern border and escarpment goes by the name of Walden's* Ridge. This ridge, including Raccoon Mountain, which is but an extension of it, cut off accidentally, as it were, by the Tennessee River, is separated from the main Cumberland by the Sequatchee Valley to nearly half way through the State. The portion of the ridge thus cut off is more or less flat on top, and from six to eight miles wide. Running northward, it connects with the main plateau, and, assuming the form of a trough, its western side becomes the eastern slope of the Crab Orchard range, while the other, now alone called Walden's Ridge, rises up and continues to limit the table-land on

* Or, more properly, Wallen's.

the east. Farther north, this or an allied ridge, still retaining the name, becomes entirely detached from the main mountain, and curves along immediately at its base. Within a few miles of Jacksboro' it runs out; but another near by, having its peculiar character, issues from the very bosom of the mountain, and, curving north-eastward, continues the line, and runs into Virginia.

These ridges, from the Emery to Virginia, are among the greatest curiosities of the whole Cumberland region. Sharp, bold, and rooflike, mostly made up of vertical sheets of solid sandstone, they appear like a vast military work, designed to protect the main mountain from the encroachments of the Lowlanders. There are very few gaps in them. To get at the foot of the mountain, though it may not be more than half a mile off, it is often necessary to ride half a dozen, to find a passage through this skirting ridge.

The Lookout Mountain, which starts up just within our State and runs into Georgia, as well as the Short Mountain of Middle Tennessee, are outliers of the table-land.

30. The *agricultural features* of the table-land present very little variety. The soils are greatly deficient in calcareous matter, and are inclined to be sandy. They are, however, far better than is generally supposed. Extensive tracts occur, covered with a mellow loam, which, at some points, yields under proper culture crops of corn, oats, etc., that would satisfy a farmer in the limestone valleys. These lands are well adapted to the cultivation of fruit, raising of stock, etc.

Nowhere in the State is there so promising a field for the application of scientific principles in the improvement of land. The foundation for an excellent soil is furnished: it needs but skilful treatment, and *the addition of lime* and a few mineral manures, to make it yield bountifully. We have already alluded to the valuable lands in Morgan, Scott, etc.

The survey can do much for all these mountain-lands, if carried out faithfully.

We now descend nearly a thousand feet, to what are yet comparatively highlands.

81. *4th. The Highland Rim of Middle Tennessee.*—The general outline and relief of all Middle Tennessee, excluding the Cumberland table-land, may be compared to a shallow plate, or rough oval basin, with a broad, flat rim. Murfreesboro' is near its centre. In travelling from this point in any direction, we pass from twenty to fifty miles, as the case may be, over rolling blue limestone land; and, finally, ascending a more or less abrupt flinty ridge, from three to six hundred feet high, find ourselves on an elevated plain. Such is the case, for instance, in going from Murfreesboro' to any of the following towns—Springfield, Lafayette, Smithville, Manchester, Fayetteville, Lawrenceburg, or Charlotte. In every instance we pass through and leave the same limestone land, ascend the same flinty ridge, and reach the same flat plain. These elevated flat lands constitute our *Highland Rim;* while the blue limestone area, below and within, we call the *Basin.*

82. Starting from along the foot of the Cumberland, the Rim encompasses the Basin, and spreads out, westward to the Tennessee River, northward into Kentucky, and southward into Alabama. Its continuity is interrupted once by Duck River, and twice by the Cumberland. The former rises upon its eastern side, flows down into and across the Basin, and, striking the Rim on the west, cuts out its valley to the Tennessee; the Cumberland flows from Kentucky through a deep valley, with deeply indented sides, into the Basin, and out again to the north-west, ten or a dozen miles below Nashville.

The lower part of the Caney Fork has a deep and ragged valley—an arm of the Basin, which runs up many miles into the highlands, and is finally terminated by falls and rapids. The tributaries of this river, as well as many other streams farther north, furnish beautiful waterfalls, from forty to one hundred feet high, as they pass from the highland down into the gorges, which open out into the valleys below.

83. This circle of highlands is noted for its beautiful and clear streams, and for its sulphur and free-stone waters. At least a score of cool and inviting summer retreats may be found located at different points, all around and just outside the Basin. The heat and epidemics of the lowland causes them sometimes to swarm with visitors.

34. In reference to *agricultural features*, the Rim may be divided into two parts. Around the Basin, at many points, the highland is known by the significant name of "the Barrens." The soil, with some exceptions, is thin, and deficient in calcareous matter. "Shrub oaks" monopolize whole square miles. The rolling or broken lands *immediately* at the escarpments, or near the edge of the Basin, afford often good land.

Farther back, however, and beyond the Barrens, limestone begins to be seen; the country is more rolling, and the soil becomes red and fertile. This red land is very characteristic of the outside part of the Rim, and affords numerous fine agricultural regions.

35. *5th. The Limestone or Central Basin of Middle Tennessee.*—This singular and unique depression—or rather excavation—the description of which we have already, in part, anticipated, has an elliptical form. It is a little more than a hundred miles long, and from fifty to sixty broad, running somewhat obliquely nearly across the State. The amount of depression is from four to six hundred feet below the plains of the Rim.

Its outline, at some points, is exceedingly rough, made up of long "spurs," which run out from the highlands. One of these, called the "Elk-ridge," dividing the waters of the Elk and Duck Rivers, extends, almost without interruption, across the southern end of the Basin; thus, in a measure, cutting off the limestone valleys in Giles and Lincoln. Occasionally, within its area, in several counties, isolated peaks, or short ridges—outliers of the "spurs"—are met with, mounting up to the level of the Rim.

36. The Basin includes the following counties: all of Rutherford, Wilson, and Marshall; the greater part of Sumner, Maury, Giles, Lincoln, Bedford, Cannon, and Smith; and portions of Macon, Jackson, and De Kalb.

The rocks of the entire area are blue limestones, divisible into two or three great groups, all of which furnish an excellent soil; and the upper group, especially, one that is unsurpassed. The Basin is truly a garden-spot. It would be difficult to meet with a region of the same

extent, anywhere, that possesses all the elements of agricultural wealth in a greater degree. We shall treat more fully of its geological characters, etc., elsewhere.

37. *6th. The Slopes of West Tennessee.*—In going west from the Tennessee River, we ascend rapidly, and soon reach the summit of the hilly and broken ridge which divides the waters of the Tennessee from those of the Mississippi. The distance of this ridge from the former river will average about one-fourth of its distance from the latter; so that the slope to the Mississippi embraces by far the greater part of the Western District. This we call the Western Slope, and its narrow and steeper counterpart the Eastern.

The two are very different in their natural features. The *Eastern* is the rocky portion of West Tennessee: here are the limestones, the marble, the iron ore of the district. Its rocks and soils resemble those of certain parts of Middle Tennessee.

38. The *Western Slope*, more or less broken by the valleys and dividing ridges of its numerous streams, descends gradually to the west, until it abruptly terminates in a long and precipitous escarpment, or "*Bluff.*" Its rivers are peculiar. They are long, sluggish, and have wide, flat bottoms, filled with heavy timber. It is often necessary "to levee" the bottoms for several miles to render them passable.

The subsoils of the eastern, and larger part of this Slope, excluding of course the alluvial bottoms, are richly colored orange and yellow—sometimes white—sands, with here and there outcropping beds of dark and occasionally light-colored clays. The soil, at many points, is excellent; at others thin and unproductive; generally it is mellow and good, susceptible, either of the highest state of cultivation, or, in the hands of a careless farmer, on account of its very mellowness, of being soon made waste and worthless.

The *green sand*, or "*marl,*" which occurs abundantly in Hardin, McNairy, Henderson, and Hardeman, will some day do much for these lands. But of this hereafter.

39. The western part of this Slope, running in a band from twenty

to thirty miles wide, and limited on the west by the Bluff above mentioned, is covered with a great stratum of *light-yellow ashen earth*, or *loam*, which yields a strong and excellent soil. It may not be saying too much to assert that Obion and Dyer, the uplands of which belong to this band, are naturally the richest counties in the State. Here, at any rate, may be seen a growth of great poplars, walnuts, beeches, white-oaks, etc., unsurpassed, we are sure, by any thing elsewhere in Tennessee. The heavy timber has really retarded the settling up of these lands.

This range, or band, runs down into Mississippi.

40. *The Bluff*, already spoken of as terminating the Slope, is a striking feature in the topography of the District. Coming out of Mississippi, it runs in a nearly direct course from Memphis to Hickman, in Kentucky. Though now cut by the small rivers of West Tennessee, on their sluggish way to the Mississippi, it was once continuous, and far more extensive westward. Its base is the eastern boundary of the great Mississippi bottom—the eastern limit of those changes that the river has experienced, in its lateral movements, from one side of its great alluvial plain to the other.

In height, the Bluff rises from one hundred and fifty to two hundred feet. Some of its highest points command an extensive view of the wild level bottoms below, over which, reaching apparently without limit to the west, the eye looks for twenty or thirty miles. A view of this kind—the forests not concealing the Mississippi—is most beautiful. We have gazed upon this wild flat world, and its rolling, moving sea, with astonishment and untiring delight.

41. Within the limits of our State, the river, in its tortuous course, now washes the Bluff at four different points; one of which, however, in low water, is deserted and left inland. These points, being conspicuous objects from the river, and relieving the continued monotony of its low banks, are familiar landmarks to the boatmen, and have been called by them the "Chickasaw Bluffs." The first occurs at Fulton; the second at Randolph; the third—no longer seen from any of the channels—at "Old River," in the lower part of Tipton; the

fourth and last is at Memphis,—and hence the appropriate appellation of the "Bluff City."

The geological relations of this part of Tennessee are full of interest, and will demand our attention.

42. *7th. The Mississippi Bottoms.*—We have already anticipated, in good part, the notice of this division. It includes all the alluvial bottoms lying between the Bluff and the Mississippi—in area equal to about eight hundred square miles. This whole region, dark with heavy forests, even yet the retreat of deer and wild animals, is not much above high-water mark; much of it, in fact, being subject to inundation.

It abounds in *lakes* and *bayous*. Reelfoot Lake, in Obion, formed by the earthquakes of 1811–12, is nearly twenty miles long, and from three to seven broad. Standing in its waters are thousands of dead cypress and other trees; the whole area appearing, indeed, like "sunken land." Most of the trees stand erect in shallow water, their dead trunks and branches covering the lake. At some points, however, they are entirely beneath its surface; and the amateur fisherman, to whom this lake is a favorite resort, can, in his boat, glide over the dead forest, submerged in the clear waters below.

43. Next to the river, and at some points inland, there are strips of country above high water, which can be, and are, cultivated without inconvenience. The soil of the whole division is alluvial, and, of course, most excellent. Some day, it is to be hoped that the extensive tracts now occasionally inundated may be successfully leveed and reclaimed.

44. Thus ends our brief sketch of the physical divisions of Tennessee. Mark the contrasts they afford! How unlike are the "Balds" of the Unaka, and the bottoms of the Mississippi—the *fluted* Valley of the East, and the river-veined Slope of the West—the wooded plains of the Table-land, and the rich rolling fields of our Central Basin! Surely there is no lack of marked variety in favored Tennessee.

CHAPTER III.

THE MINERAL WEALTH OF TENNESSEE: THE ORES AND METALS.—DEVELOPMENTS OF THE SURVEY: DETAILS OF WORK TO BE DONE.

45. In this and the following chapter we propose to give a descriptive outline of the useful minerals and mineral products of the State, together with notices of their localities, so far as developed and reviewed by the present survey. We will also add all the statistics that we have been able to gather in regard to the production and operations of the different mines, banks, iron and marble works, etc.

We trust the summary thus given will be satisfactory and reliable. No labor has been spared on our part to make it so. If deficiencies are detected, the extent of country to be explored, and the shortness of the time hitherto allowed us, constitute a sufficient apology.

This will afford a starting-point for still further developments. It lays a most inviting field before us, and points to a mineral wealth for Tennessee unsurpassed for its variety and extent.

SECTION I.

IRON.

46. The amount and variety of iron-ore in Tennessee; its excellent quality; the general favorableness of its association with all the conditions for the economic manufacture of iron, surpass any thing we had conceived of. Vast indeed is its importance to the State. Below, we have classified our iron-banks and localities; described, and given to the great regions into which they can be grouped, specific names.

This, which has never been done before, will enable us to speak of them more definitely, and will greatly facilitate the practical objects in view.

47. There are *four* of these iron regions, all differing, more or less, in geological and mineral characters, as follows:

First, The Eastern. This runs through the State, and lies along and in front of the Unaka group of mountains. Most of its banks occur in the coves included in the mountain ridges.

Secondly, The "Dyestone" Region. This skirts the eastern base of the Cumberland, and Walden's ridge, from Virginia to Georgia. It extends out laterally into the Valley of East Tennessee from ten to twenty miles. The Sequatchee and Elk valleys are included.

Thirdly, The Cumberland. Associated with the coal measures, on the mountain, in the northern part of the State,—a new development of the survey.

Fourthly, The Western Region, occupying a wide strip of the western part of Middle Tennessee, and a portion of the District. This extensive field runs from out of Kentucky to the Alabama line.

We will notice each of these, so far as our investigations up to this time will permit, with reference to their extent, ores, banks, and iron-works. We will also add such practical suggestions as may occur to us.

We trust the attention of capitalists and iron-masters abroad may be called to these promising iron-fields of Tennessee.

FIRST, THE EASTERN.

48. *Its extent, Coves, etc.*—This iron region includes the counties of Johnson, Carter, Sullivan, Washington, Greene, Cocke, Sevier, Blount, Monroe, Polk, and the eastern part of McMinn, or, in other words, those counties in which the Unaka group, with its outliers and included valleys and coves, is found. (See §§ 18 and 19.) It is in these valleys and coves that most of the ore-deposits occur. The picturesque valleys of Johnson, the valley of Stony Creek in Carter, Bompass and Greasy Coves in Washington, those in Greene, the coves

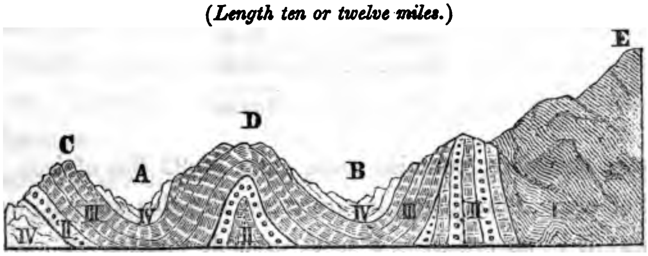
back of Chilhowee in Sevier and Blount, those back of the outliers, in Monroe, and Star's Mountain farther south, are examples. In these and in similar coves and valleys, including those which skirt the outliers on the west, iron-ore is found, and is to be looked for: no doubt numerous fine banks remain to be discovered, notwithstanding the great number known. Many of these valleys and coves are from ten to twenty miles long, and from one to five miles wide. Those in Johnson and Carter, especially, are remarkable for their extent, and their numerous iron-banks.

49. Although it is anticipating to refer to the formations of the State, as adopted in chapters fifth and sixth, yet we think it advisable to notice here the typical geological character of these iron-bearing valleys and coves. It is the same for nearly all of them.

The bottoms of these troughs or valleys are occupied by soft reddish and variegated shales and slates, and heavy magnesian limestone, —Formation IV.,*—all very much leached and cut into knobs and long ridges by the action of water for many long ages; while hard sandstones—Formation III.—rise up and form their mountain sides. It is upon the first of these, the shales and limestone, the latter especially, that the banks of ore rest, forming, in many cases, with loose earth, etc., bold knobs and ridges. The section below will serve to illustrate the geological structure of these coves or troughs.

SECTION ACROSS BOMPASS AND GREASY COVES, IN WASHINGTON.

(Length ten or twelve miles.)



A, Bompass Cove. B, Greasy Cove. D, Rich Mountain, separating the coves. E, Summit of the main mountain on the line. The numbers refer to the formations.

* See Chapter VI. for information in regard to all the formations mentioned.

50. Such is the *typical* character of the coves and iron-bearing troughs of the eastern region. Occasionally, however, they are flanked on but one side by a mountain range. In some instances, though but few, formation I. forms the skirting mountain on the east, Nos. II. and III. being absent. In a few cases, extensive banks, as those in Sullivan and one in McMinn, are entirely detached from the main mountains, and sustain no particular relation to them. These are exceptions, and are thrown into the eastern region on account of their proximity, and for convenience.

51. *Its Ores.*—This iron field affords three species of ore, as follows:—

1st. *Brown Iron Ore, or Limonite;*

2d. *Red Iron Ore, or Hematite;* including two varieties—

(*a*) *Hard solid Ore, or Red Hematite;*

(*b*) *Stratified Dyestone Ore;*

3d. *Magnetic Iron Ore, or Magnetite.*

52. We shall speak of the character, mode of occurrence, extent, etc., of each of these ores separately.

1st. *Brown Ore, or Limonite.*—This is also called *Yellow Iron Ore, Hydrous Peroxyd of Iron, Brown Hematite,* etc., etc. It is the great ore of the Eastern Iron Region, and will always be meant in speaking generally of its ores, unless the others are specified. Its powder is *yellow.** When pure, it consists of

Iron	59·92
Oxygen	25·68
Water	14·40
	100.00

It never, therefore, contains more than 59·92 lbs. of iron in one hundred of ore. Practically, it rarely contains this amount, owing to impurities; it is, nevertheless, a most valuable species, on account of the facility with which it is worked, etc.

* The color of the powder of minerals is characteristic, and often aids in determining them.

53. In the field before us, it occurs both as "honeycomb" and hard solid ore—occasionally in grains, and called shot-ore—sometimes in ochreous and earthy forms. It exists in the banks in masses of all sizes, from small lumps up to blocks and beds, sometimes ten or fifteen feet in diameter. It is found, too, in contorted layers, from a few inches to two or three feet in thickness, partially stratified with seams of earthy matter, and, in some cases, more or less parallel to the irregular surface of limestone rocks below.

54. The knolls, hills, and ridges, which generally afford the most important banks, though some of them are in low grounds, are from fifty to two hundred feet high, and often many miles long. Many of these are made up of but little else than ore and earth; some abound in chert, or flinty matter, others in slaty matter, through which the ore is scattered in rough veins or beds. The latter is true especially of those based on the slaty part of Formation IV.; many of these furnish large masses of excellent ore, but sometimes especial care is required in separating the slaty portions.

Altogether, these ores of the Eastern Iron Region are excellent, and practically inexhaustible. The wrought iron produced from them is generally of the first quality, and greatly in demand.

55. Considerable of the superior ore of Johnson, Carter, and Washington contains *lead* and *zinc*. The ore of Bompass Cove, and that used at Carter's furnace, in Carter county, are of this character. The iron made from both is excellent. Often, after blowing out, several hundred pounds of lead have been obtained in the crevices of the stacks. The zinc collects in a hard incrustation around the mouth of the furnace.

In regard to the number and extent of the banks affording this ore, Johnson and Carter stand at the head of the list. Washington is next; then come the remaining counties. Hereafter we hope to be able to speak of each bank in detail.

56. 2*d*. *Red Iron Ore, or Hematite.*—This is also called *Peroxyd*

of Iron, *Specular Iron*, "*Dyestone*," etc. Its powder is *red*. When pure, it contains

Iron	70
Oxygen	30
	100

Hence one hundred pounds of this ore might afford seventy pounds of iron. In practice, however, as in the case of brown ore, the maximum per-centage is never reached, on account of impurities. All the red ores of iron are referred to this species.

57. As before stated, there are two varieties of it in the iron region under consideration.

(*a*) *Hard Solid Ore, or Red Hematite.*—We know of but three or four localities of this ore in Tennessee, excepting those of the small cabinet specimens of specular iron that occasionally occur in the older formations.

The first is the Cannon bank, seven miles from Elizabethton, in the valley of Stony Creek. The ore occurs here in a regular and solid stratum, varying from one to two feet in thickness. It rest upon a thin stratum of conglomerate, of pea-like quartz pebbles, while above and below the rocks are sandy slate, or shale, all having a gentle dip. There is some doubt in regard to its exact geological position. It may belong to the upper part of Formation III., though, as yet, we regard it as belonging to the shales and slates of IV. It is worked at Nave's forge, and yields a good iron.

58. The other localities which have come under our observation are in the eastern part of Sullivan, a mile or two west of the Holston, and near the residence of Mr. James Cowan.

One, known as the "Crockett bank," half a mile south-west of Cowan's, is an extensive bank or ridge of red earth, with numerous small blocks of solid hematite scattered through it. Near the surface, it is associated with more or less "honeycomb" brown ore. There is another locality about a mile and a half in the same range to the north-east, not as yet opened, which, from external appearances, promises to be valuable.

59. About one and a half mile north-west or north of Cowan's, at the "Sharp bank," is an interesting vein-like mass of the same compact ore, varying from four to six feet in thickness. It has been excavated to some depth, and appears to run down vertically in the limestones of group IV. It is capable of affording much good ore.

The neighboring localities, just spoken of, are doubtless associated with the same limestone. It may be that the loose blocks have been derived from a vein like the last, which has not yet been exposed. Some of the small blocks were seen with imbedded crystals of quartz.

At all of these localities the ore is more or less magnetic. They have been worked to considerable extent by the furnaces and forges of Sullivan.

60. (*b*) "*Dyestone*" *Ore.*—There is one interesting and extensive deposit of this ore, which, on account of its proximity to the Unaka group, we have found convenient to throw into this iron region. Its character, however, connects it with the next to be described. It is Hill's bank, in the eastern part of McMinn. The ore is a stratified, fossiliferous, iron-rock. The main deposit is a third of a mile or more in length, and at some points fifty or sixty feet wide. It is, indeed, a noble bed. For three or four miles, along its range, traces of the ore occur, and at several points it swells out into other important deposits.

The ore is composed, in good part, of flattened oölitic or rounded grains, and frequently contains impressions of crinoidal joints. Owing to its separating into small blocks, it is sometimes styled "block ore." A small bloomary, five miles distant, uses the ore, and makes good iron—said to be "hard and tough." The erection of a steam-power furnace, at some point convenient both to fuel and the bank, would, we think, be fully justified by the character of this deposit.

In regard to its geological relations, it is most likely the dyestone member of Formation VI., occupying here, mostly detached from its associates, a great dislocation in the strata. The mass exposed appears to be the outcropping edge of the stratum—the rocks in the vicinity dipping to the south-east. This is a point, however, to be investigated more fully hereafter.

61. 3*d*. *The Magnetic Ore, or Magnetite.*—This is the species to which lodestone belongs. Its powder is *black*, and highly attractable by the magnet. The pure ore is composed of

Iron	72·4
Oxygen	27·6
	100·0

So that 100 lbs. of *pure* ore contain 72·4 lbs. of iron.

62. This is a rare ore in Tennessee. We know certainly of but one locality affording it in workable quantity. Another, in Cocke county, is barely mentioned by Dr. Troost. The first locality—which we have visited—is in Crab Orchard, Carter county. It is about six or seven miles from the summit of the Roan, and lies at its base. The ore is associated with a greenish crystalline mineral, called *sahlite*, and occurs with this, and with the decomposing gneissoid rocks around it, in irregular layers, patches, and wedge-shaped masses, often several feet or yards in length. No well-determined vein has been exposed, though the ore and sahlite are found along a certain range for some distance.

The masses taken out and used are composed of grains of ore mixed, more or less, with foreign matter, such as quartz, sahlite, etc. The locality occurs in Formation I., or the Mica-Slate series.

The ore is worked at Hampton's bloomary, near the locality, and yields a most excellent iron. Several miles farther east, in North Carolina, are the Cranberry Iron Works, which use the same kind of ore.

So much for the ores of the Eastern Iron Region.

63. *Its Furnaces and Forges.* Statistics of these are given in the tables at the close of the article on Iron.

There are nine furnaces, and all, but Tellico, cold blast; of these, five were in operation in 1854, and produced 1855 tons of cast-iron—Tellico and Pleasant Valley producing by far the greater part.

The forges are much more numerous, there being thirty-nine, of which thirty-two are bloomaries and seven refineries; making altogether, in 1854, 912 tons of bar-iron, and 480 tons of blooms.

In addition to these, there is a rolling-mill in connection with Pleasant Valley Furnace.

For remaining statistics, reference can be had to the tables.

64. *Remarks, etc.* Although the actual production of this iron region is considerable, yet it can be and ought to be greater. Hitherto, a serious difficulty has been the want of a suitable market. The railroads of East Tennessee, however, and a fresh and vigorous enterprise, are about, in a great measure, to remove the difficulty. There is one suggestion, nevertheless, which we must be permitted to make, and that is with reference to an outlet for the iron of Johnson and Carter.

A good *macadamized road,* leading from Taylorsville down one of the valleys to the Watauga, thence out through Elizabethton to the nearest railroad dépôt, with strong and good bridges over all the streams, is very much needed; it would give new life to the iron business in these counties, and, without doubt, quadruple it in a few years. As a matter of policy, the State, perhaps, ought to aid in this enterprise. We desire to see several furnaces and a rolling-mill in Johnson, and with such a road, in a few years there would be.

65. We now pass to the western part of the Valley of East Tennessee. The middle part—that included between the iron regions—has not, as yet, afforded any very extensive banks, or localities of iron-ore. Small deposites of the brown ore, however, are very numerous. They can be found upon most of the cherty ridges, which are based on the limestones of Formation IV. The ore occurs, within limited areas, scattered through the soil. At some points enough could be obtained to supply a bloomary for several years. No forges, however, nor furnaces, are located in this part of the valley.

SECONDLY, THE DYESTONE REGION.

66. This differs from the Eastern in its geographical position, in its geological relations, and in its ores.

Its extent.—Running from out of Virginia into Georgia and Ala-

bama, it occupies a narrow strip of the State, lying at the base of the Cumberland and Walden's ridge, in the counties of Hancock, Claiborne, Grainger, Campbell, Anderson, Roane, Rhea, Meigs, and Hamilton; we include, also, the Sequatchee and Elk Fork Valleys—the former in Marion and Bledsoe, and the latter in Campbell.

67. *Its Ores.*—The great ore of this field is the stratified red ironstone, called at many points *dyestone*, being sometimes used for dyeing purposes. It is a variety of the red iron-ore, or hematite, and has already been spoken of. (See § 60.)

It soils the fingers readily, and is generally made up of small rounded and flattened bodies—for which reason it is often called *lenticular* ore. These bodies are generally minute, but sometimes half an inch or more in diameter, and irregular in outline; occasionally they become thin scales. Not unfrequently the ore is partly made up of fossils—shells, corals, crinoidal joints, etc., converted into iron-ore; sometimes it is covered with their impressions, or filled with their empty moulds, the substance of the fossils having been leached out by water.

68. At some points the ore is hard enough to be quarried out in blocks, which is the case at Cumberland Gap; at other points it is soft and easily crushed, as at Kimbrough's bank in Roane.

The prevailing color is brownish red, though we have seen bluffs of it of a beautiful crimson red. When first quarried it is fresh in appearance, and the peculiar bodies spoken of, or the scales, have a bright steel-like color and lustre, approaching, in a few cases, in the soft variety especially, a true scaly specular ore. Found in fragments along the outcrops, on the ridges where it has been exposed for ages, it occasionally has a dull, dark, sandy and spongy appearance, and is, when of this character, of but little value. It serves, however, in this case, as a guide to the better ore below.

The impurities contained in the dyestone are sandy and argillaceous matters, carbonate of lime, etc.

69. Generally, the iron produced is excellent, both the pig-metal of the furnaces, and the bars of the bloomaries. At a few points, however, the bar-iron inclines to be *cold-short.*

The chemical examination of the ores producing such iron is greatly desired; in fact, the examination of all, good and bad, will be of service. The knowledge of their composition, thus derived, will enable iron-masters to manage them much more satisfactorily.

In addition to the dyestone, brown ore is found on the ridges, under circumstances similar to those already mentioned with reference to the middle part of the valley. (See § 65.) The two are sometimes mixed, with good results.

70. *Geological Position of the Dyestone.*—Although, as before remarked, (§ 49,) the discussion of geological relations belongs to a different part of the report, yet it is necessary, in this case, to refer to those of the dyestone. It is, as we have already said, a stratified ore; or, in other words, it occurs, like an ordinary limestone or sandstone, in a layer or stratum. For this reason it can be traced out, and its quantity calculated, with far more precision than can be done for the other ores which have been mentioned. It is generally associated with variegated shales, or soft slates, and thin layers of fine sandstone. At some points the strata are more or less calcareous, and approach limestones in character. Imbedded in these rocks, it in general forms with them sharp straight ridges, which run along parallel with the eastern outline of the Cumberland.*

The section on the following page will exhibit its mode of occurrence.

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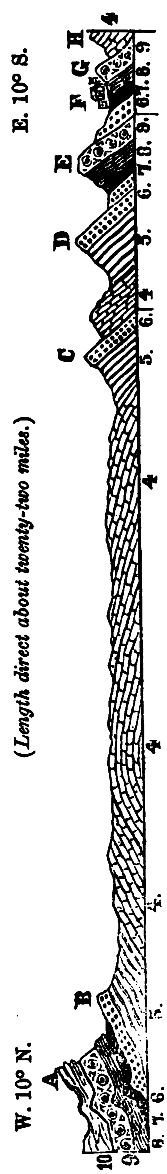
* In speaking of the occurrence of the dyestone, or, as it is often called, the lenticular argillaceous ore, we have, in this and the following articles, confined ourselves to Tennessee. It has, however, a wonderful range beyond the limits of our State. If identical with a similar stratified ore, in a series of rocks called, by our northern friends, the Clinton group, of which there is but little doubt, it stretches out northward through Virginia, Pennsylvania, into New York, and even into Canada. It has, in fact, been traced out over a good part of this entire range. At numerous points in the States mentioned, it supplies furnaces and forges with ore. Southward, it reaches, as Professor Tuomey informs us, in his report of 1849, many miles into Alabama, where it finally disappears beneath more recent formations. This extent, considering that the beds are very seldom more than three feet thick, and often but a few inches, is truly wonderful.

We appear to have in Tennessee our full share of this valuable ore. So far as we have been able to ascertain, it occurs nowhere in beds thicker or more plentiful.

Formation 6 is that which contains the dyestone as one of its members. The layer of ore is from a few inches to two feet thick, or more in some cases. The shales and smooth thin sandstones occur above and below it.

SECTION FROM CUMBERLAND GAP TO SNEEDVILLE, IN HANCOCK COUNTY.

(*Length direct about twenty-two miles.*)



A, "Pinnacle" of the mountain at the Gap—a "corner-stone," by the way, of Virginia, Kentucky, and Tennessee. B, a long ridge skirting the base of the mountain, and rich in dyestone. C, Wallin's Ridge, also containing dyestone; this ridge is fourteen or fifteen miles from Cumberland Gap. D, Powell's Mountain—contains the ore in limited quantity. E, Newman's Ridge. F, Sneedville. G, Ridge beyond Sneedville. H, "Comby" Ridge. The three mountains, or ridges, C, D, and E, constituting Powell's Mountain Group, are spoken of on page 22. The formations are numbered as described hereafter. Refer to the table at the end of Chapter Fifth, or to Chapter Sixth.

No. 7 is a stratum of *black slate*, resting upon the formation including the dyestone, and is often useful as a guide in searching for the ore. No. 5 is a great group of blue limestones below it.

Formation 6 occurs four times in the Section. At B, the rocks dip gently to the north-west, and run under the mountain. The ore is *quarried* near the surface, on the north-western side of this ridge.

At C and D the rocks all dip rapidly to the south-east; in this case the outcropping edge of the ore is worked.

71. *Particular Ranges and Amount of Ore.*—The following are the ranges which we have traced out more or less perfectly.

1*st.* Commencing at the Cumberland Gap, the stratum of ore at B, in the Section just referred to, coming out of Virginia, skirts the mountain closely, with but few interruptions, all the way down to Georgia, a distance of nearly one hundred and sixty miles. There are not more than three or four interruptions, averaging in length two or three miles each; so that

in this range we have what may be regarded as a continuous band of ore, one hundred and fifty miles in length!

At Cumberland Gap the ore is from twenty-four to thirty inches thick, and of excellent quality. We visited a locality in Roane, belonging to Gen. G. L. Gillespie, of Kingston, where the ore appeared to be seven or eight feet in thickness, though as yet no excavation has been made. At other points near by, which we could not visit at the time, it is said to be much thicker. In the southern part of the State it is less important. Its entire average thickness must be at least twenty inches; perhaps it is more.

At numerous points its quantity is greatly increased by the folding of the strata, giving often three or four parallel bands within a few hundred yards.

72. *2d.* In Wallin's Ridge, and Powell's Mountain, in Hancock and Claiborne, ranges of ore occur from ten to fourteen miles long. That of Wallin's Ridge is the most important, averaging ten or twelve inches. The ore does not appear to occur again, going eastward from Sneedville.

73. *3d.* There is a very important band commencing ten or eleven miles below Tazewell, near the mouth of Big Barren Creek, and running down through Anderson, east of Clinton, and, with some interruptions, through Roane into Rhea and Meigs. It is nearly or quite one hundred miles long; at many points two and three feet in thickness. What has been said of the lateral multiplication of the first band is true of this.

This range crosses the Clinch, and, below Kingston, the Tennessee River, at many points—a circumstance which renders the transportation of the ore, to considerable distances, cheap and convenient.

74. *4th.* The valley of the Elk Fork, in Campbell County, is a remarkable and valuable locality of this ore. This narrow valley, commencing nearly twelve miles north-west from Jacksboro', is a great and abrupt depression, or gorge, in Cumberland Mountain. It is long, nearly straight, and runs north-eastward into Kentucky, along what geologists call a *dislocation*, or a great fracture in the rocks.

The upper strata have been partially removed, and the valley cut out by water.

The dyestone group forms the bottom rock in the upper part of the valley. Owing to the great number of minor folds, or wrinkles, in the rock, the ore-layer is repeated a great number of times, and crops out in numerous parallel bands for a distance of about five or six miles; many of these are from twenty inches to three feet thick.

On both sides, and at the head of this curious deep trough, the mountains are high, and abound in stone-coal.

75. *5th.* In the southern part of the State there are numerous bands of ore, which possess more or less interest.

One runs along with White Oak Mountain, and can afford considerable ore.

There are two about Lookout Mountain, one on each side; these converge northward, and finally meet a few miles above Chattanooga. Other limited ranges occur in Hamilton.

In Sequatchee Valley the ore appears; traces, and some good deposits, could be found at intervals on both sides.

76. *Furnaces and Forges.*—As in the case of the Eastern Region, the facts in regard to these are given in the tables. There are, it will be seen, five furnaces, two of which have steam-power, and are hot blast. Only two of the number were in operation in 1854, producing 1168 tons of cast-iron. One, the Bluff furnace, at Chattanooga—a new and excellent establishment—has gone into operation within the present year.

The forges, 15 in number, are all bloomaries, and produced in 1854 257 tons of bar-iron.

We hope within a few years to see many more iron establishments in this fine field.

THIRDLY, THE CUMBERLAND IRON REGION.

77. While examining the coal-strata of Cumberland Mountain, in Anderson, Morgan, Campbell, Scott, etc., the pleasure was afforded us

of discovering valuable deposits of an iron-ore not before observed, so far as we are informed, in Tennessee. It is the *clay iron-stone;* in appearance, and in composition, quite different from those at present worked within the State.

It is an impure carbonate of iron. An analysis before us, by Professor Rogers, of one of the best specimens found in Pennsylvania, is, in 100 parts of ore,*

Protoxyd of Iron,	53.03
Carbonic Acid,	35.17
Lime,	3.33
Magnesia,	1.77
Silica,	1.40
Alumina,	0.63
Peroxyd of Iron,	0.23
Bitumen,	3.03
Water,	1.41
	100.00

Throwing it into another form, we have, in 100 parts,

Metallic Iron,	41.25
Oxygen of the Protoxyd above,	11.78
Carbonic Acid,	35.17
Impurities and Water,	11.80
	100.00

The best ores, therefore, contain a little more than 40 per cent. of pure iron; practically they yield 30 or 33—sometimes, however, approaching 40.

This ore occurs in nodules and balls, or in flattened concretions, disposed in layers, and interstratified with the shales of the coal-measures. These balls, or concretions, run up in size from small pebbles to masses weighing a ton or more.

78. The clay iron-stones are generally considered a variety of the crystalline carbonate of iron called *spathic* or *sparry iron.* Though not as rich as some ores, they are, nevertheless, highly valued on account of their association with stone-coal.

* Taken from Overman's Manufacture of Iron, p. 30.

Whitney, in his "Metallic Wealth of the United States," says: "This is, perhaps, the most important ore of iron; not generally in its sparry state, but as a mixture with clay and the hydrated oxyd which results from its decomposition, and as constituting a part of the great Carboniferous Formation; hence, occurring with the coal required for its reduction, it becomes of great importance."

Again: "It is to the abundance of her coal-measure iron-stones that England is indebted for her vastly preponderating production of this metal; and it is thus that she has been able to supply the rapidly increasing demand for railway iron, which the discovery of a new means of national intercommunication rendered necessary. The coal-fields of North and South Wales, North and South Staffordshire, etc., while they furnished fuel to smelt the ore, furnished the ore itself, and the necessary flux from the same shaft, with hardly any increased expense beyond what it would have cost to raise the coal alone."

79. In the course of our investigations in Tennessee, we have seen a bluff of shale forty or fifty feet high, with numerous layers of these nodules and balls occurring through it. It is not our object, however, to give at present any details in regard to its amount, extent, etc. This we defer until further and more extended observations are made. From what has been seen, we attach much importance to these discoveries, and feel confident of adding another important iron-field to those already known.

80. There is another ore of iron which has lately attracted much attention in Scotland and other countries. It is a *coaly* impure carbonate of iron, peculiar to the coal series, and called the *black-band* or *Mushet iron-stone.* Indications of this have also been discovered in our coal-measures, which we regard with much interest, and which may, by future developments, become important.

Finally, in addition to the carbonates of iron, more or less brown hematite is scattered over the Table-land. What its importance is remains to be seen.

FOURTHLY, THE WESTERN IRON REGION.

81. *Its Extent and Ore-banks.—How the Ore Occurs.*—This great iron-field lies in the counties of Stewart, Montgomery, Benton, Humphreys, Dickson, Decatur, Perry, Hickman, Lewis, Hardin, Wayne, and Lawrence. It runs directly through the State, and is about fifty miles wide. The whole area is an extended plain, cut up by the valleys of streams flowing into the Tennessee, Duck, and Cumberland Rivers, and by the valleys of the rivers themselves. Between these valleys there are often wide flat areas—characteristics of the Highland Rim of Middle Tennessee, (§ 31,) to which, by the way, this iron region mostly belongs. Occasionally the country is rolling, especially the limestone portion of it.

82. Over this whole region, valuable deposits, or *banks*, more or less isolated, some of them of great extent, are freely scattered. Though in some respects similar to the banks of the Eastern Region, yet they differ in their geological relations, rest upon a very different limestone formation, and do not occur in long troughs, or coves bounded by mountains. We find them in, or in good part forming, many of the "knobs" and ridges, which, rising up from one hundred to three hundred feet, lie in between the small branches, or skirt their valleys. At many points these ridges, extending for one, two, or, in a few cases, even three miles, are made up of deep and immense masses of flinty matter, or chert and ore mixed with clay, all resting upon a siliceous or cherty* limestone basis. The limestone does not always appear near the banks, being covered over by their loose masses to a depth of from fifty to two hundred feet—such being the thickness of the deposits.

83. The *ore* occurs in great blocks, lumps and "pots," isolated or in great heaps, or in irregular veins, layers, etc., from a foot to twenty or more feet in thickness, scattered at intervals through the banks, in among the clay and chert.

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* *Chert* is an impure flinty rock. Masses of it are common in some limestones.

Such is the general character of the heavy deposits. Some of the localities do not abound in chert, but afford the ore in beds of red clay alone.

The ore is raised from excavations made either in the tops of the ridges, or in their sides—all being open to the day. As yet, in the aggregate, but little impression has been made upon it. It appears to be almost or quite inexhaustible. Hereafter we hope to be able to give a catalogue of the banks, adding all the important facts in regard to them.

84. We have as yet confined our attention to the western side of the Highland Rim; but this iron-field has, in fact, a counterpart, though of much less extent and importance, on the eastern side, lying in the range of counties along the base of the Table-land, including White, Warren, Coffee, etc. These counties have afforded some ore, and one bloomary is now in operation on Rocky River, in Warren. We look forward with interest for greater developments in this detached section.

85. *The Varieties of Ore.*—With the single exception of the Marion bank, near Clifton, in Wayne, they all belong to one species—the brown iron-ore, or limonite. (§ 52.) The varieties occurring are the compact, "honey-comb," pot, and pipe ores and ochre. The first three are common, and are found at nearly all the banks. "Pots" often occur, filled with decomposing chert, frequently with water, and a few have been noticed enclosing splendid crystals of selenite. The pipe ore is abundant at some localities in Stewart.

The ores are generally excellent, and make good iron. We propose, hereafter, to analyze and classify them all, so far as necessary. The following analyses were made by Dr. Troost.

No.	Peroxyd of iron.	Oxyd of Manganese.	Water.	Earthy matter and loss.	Per cent. of pure iron.	Locality.
1	88·0	1·0	14·0	2·0	58·1	Perry county. (?)
2	63·0	2·0	15·0	20·0	44·1	Hickman county.
3	80·0		12·0	8·0	56·0	Brownsport.
4	80·0	1·0	15·0	4·0	56·0	Bear Spring.
5	76·5	5·0	12·0	6·5	53·5	" "

86. The ore of Marion furnace is red, and related to the "dyestone." (§ 67.) It is a fine granular ore, at some points hard and compact, at others soft, unctuous, and staining a deep red. It occurs in several knobs in the region, and is irregularly arranged in layers, with red clay and shaly matter. The ore is highly esteemed, and yields an excellent iron.

87. *Geological Relations of the Western Iron Region.*—The rock upon which the deposits are based is the lower or cherty part of the Carboniferous Limestone, or perhaps, in some cases, the upper part of the Siliceous Group.* The loose chert of the banks often contains carboniferous fossils, and at some points, with the clay and iron-ore, affords obscure traces of original stratification. In fact, the banks sometimes appear, as perhaps they are, like great leached masses, the insoluble residue of many feet of cherty limestone, the calcareous part of which has been dissolved and removed by water.

We are inclined to think that the ferruginous chert of this limestone has been the great source of the peroxyd of the ores. Liberated by its decomposition, the iron-oxyd, in some form or other, has permeated the loose leached masses, and has been finally left in the beds, veins, pots, pipes, etc., in which we now find it. There are many facts supporting this view.

We will add, however, that at many points the banks afford waterworn gravel—carboniferous cherty pebbles—an evidence of drift action, due, however, it may be, to local or littoral causes. We shall take another opportunity to speak of this interesting subject.

The Marion bank alone rests upon "knobs" of the "gray lime stone" group.

88. *Furnaces and Forges.*—There are in this splendid field thirty-five furnaces, and the blast of all but two created by steam-power. Many of them are extensive and elegant establishments. Thirty-one were in operation in 1854, and made 37,288 tons of iron.

There are four bloomaries, making, in 1854, 91 tons of bar-iron.

* For descriptions of these formations, see Chapter VI.

The refineries, thirteen in number, are generally efficient establishments, having about fifty-nine fires. They made in 1854, 6,808 tons of blooms, and a few tons of bar-iron. Further statistics are given in the tables.

89. *Suggestion.*—The development of this iron region *would be greatly facilitated* by the building of two macadamized roads, which would be comparatively short and cheap; one, say, from some point in Hickman, south of the Duck River, out to the Tennessee; another from the northern part of Hickman, or the southern part of Dickson, to the nearest dépôt of the contemplated railroad to pass through the latter county, or, if that is not built, out also to the Tennessee.

The character of the country through which they would pass, admits of good and cheap roads. We think this a matter of much importance, the effects of which would be to greatly increase the wealth of those counties, and thus to augment the revenue of the State.

90. *Conclusion, Fuel, Tables, etc.*—This concludes our present account of the iron-ores and iron-fields of Tennessee. We regard it simply as an outline of the subject, yet we trust it will serve to convey an idea of the extent and value of our resources, and to awaken in the State more interest in the manufacture of this metal, which, if not one of those technically called *precious*, is nevertheless practically *more precious* than all.

91. We add a word in regard to the *fuel* used by our furnaces and forges. As yet it is throughout the State wholly *charcoal.* Wood in the iron-fields is cheap and abundant, and will be for many years. When we need it, we have inexhaustible supplies of stone-coal in the bosom of our Table-land, and by that time railroads, as well as our rivers, will bring it to the very mouths of our furnaces.

92. In reference to the *tables* which follow, we can simply say, that we have labored to make them accurate. Very many of the furnaces and forges have been visited in person, and most of the information has been obtained from the iron-masters themselves. Hereafter we shall aim to complete the tables, by adding columns of the cost and amount of ore and fuel, the cost and kind of labor, the capital invested, etc., etc.

93. TABLE OF THE TENNESSEE FURNACES, INCLUDING THEIR PRODUCTS IN 1854, ORES USED, ETC.

(a) *Eastern Iron Region.*

No.	Name.	Owners.	County.	PRODUCTS OF 1854. Pig Metal and Castings.	Castings alone.	Months in blast.	Kind of Ore.	REMARKS.
1	Union	Carter & Co.	Carter.	250	....	....	Br. hematite.	
2	O'Brien's	....	"	....	....	....	....	Out of blast since 1840.
3	Bushong's	William Bushong.	Sullivan.	105	25	....	Red hematite.	
4	Welcker's	Welcker, Beidleman & Co.	"	....	....	....	"	In blast during 1855.
5	Pleasant Valley	R. L. Blair & Brothers.	Washington.	700	100	6	Br. hematite.	Con. with refin. and r. mill.
6	Clark's Creek	" "	"	....	....	....	"	Out of blast since 1844.
7	Bright Hope	John Shields.	Greene.	....	....	....	....	Out of blast for several years.
8	Tellico	Welch, Harris & Co.	Monroe.	780	....	7	Br. hematite.	
9	Ball Play	S. S. Glenn & Co.	"	70	....	2	"	

(b) *Dyestone Region.*

No.	Name.	Owners.	County.	Pig Metal and Castings.	Castings alone.	Months in blast.	Kind of Ore.	REMARKS.
10	Cumberland Gap	John G. Newlee.	Claiborne.	238	38	4	Dyestone.	
11	Crockett's	Rose & Fugate.	"	....	....	....	D. and br. h. ?	In blast in 1855.
12	Sharp's	....	Grainger.	....	....	....	Dyestone.	Repairing.
13	Eagle*	E. T. Iron Manufac'ng Co.	Roane.	930	....	7	"	
14	Bluff*	" "	Hamilton.	....	....	....	"	New, capacity 10 tons a day.

* Blast created by *steam*-power; that of the others by *water*-power. Nos. 8, 13, and 14, are *hot blast;* the others *cold blast.*

TABLE OF FURNACES, ETC., CONTINUED.

(c) *Western Iron Region.*

No.	Name.	Owners.	County.	Products of 1854.			Kind of Ore.	Remarks.
				Pig Metal and Castings.	Castings alone.	Months in blast.		
15	Brownsport*.......	Ewing, Dick & Co.	Decatur.	2109	....	11.5	Br. hematite.	
16	Decatur*...........	Golladay, Cheatham & Co.	"	....	....	....	"	Started Jan. '55, cap. 2000 t.
17	Marion*............	J. J. H. & J. K. Walker.	Hardin.	915	?	6	Red hematite.	Made some sugar kettles.
18	Forty-eight*.......	F. & S. Pointer.	Wayne.	2445	....	12	Br. hematite.	Uses two stacks alternately.
19	....	....	Lawrence.	....	....	....	"	Out of blast for several years.
20	Cedar Grove*......	William Bradley & Co.	Perry.	1500	?	....	"	Uses two stacks alternately.
21	Ætna*...............	Goodrich, Fell & Hillman.	Hickman.	1509	....	9	"	
22	Oakland*...........	Studdurt, Foulkes & Bratton	"	385	....	8	"	
23	Worley*............	James L. Bell.	Dickson.	950	....	....	"	Has a refining fire.
24	Jackson.............	Estate of M. Bell.	"	50	....	....	"	In blast but a few w'ks of '54.
25	Piney*..............	Napier & Holt.	"	1781	70	....	"	
26	Laurel*.............	William C. Napier.	"	357	....	4.5	"	Has a refining fire.
27	Cumberland*.......	Anthony Vanleer.	"	1926	....	....	"	
28	Carroll*.............	Robert Baxter.	"	1050	....	9	"	
29	Louisa*.............	Jackson, McKernan & Co.	Montgomery.	2154	....	....	"	
30	Sailor's Rest*.....	Isaac D. West.	"	600	....	7	"	In '54 water-power, now st'm.
31	Yellow Creek*.....	Robert Steele.	"	600	....	....	"	Same as last.
32	O. K.*...............	Caldwell, Vanleer & Co.	"	1160	....	....	"	
33	Phœnix*............	....	"	1500	....	11.5	"	
34	Montgomery*.....	Russell, Robertson & Co.	"	1000	....	....	"	
35	Poplar Spring*...	John H. Jones & Co.	"	1175	....	....	"	
36	Saline*.............	Lewis Irwin & Co.	Stewart.	1200	1200	....	"	Iron made into sugar kettles.

(c) *Western Iron Region*—(Continued.)

No.	Name.	Owners.	County.	Products of 1854.			Kind of Ore.	Remarks.
				Pig Metal and Castings.	Castings alone.	Months in blast.		
37	Great Western*...	Newell & Pritchett.	Stewart.	....	....	....	Br. hematite.	Started in 1855, of large capacity.
38	Iron Mountain*...	Brien, Ledbetter & Co.	"	1015	....	4	"	New furnace.
39	Peytons*	Thomas Kirkman.	"	1220	....	7	"	
40	Bellwood*..........	Woods, Lewis & Co.	"	2006	....	....	"	
41	Cross Creek*......	Newell, Irvine & Co.	"	1905	....	11.5	"	
42	Rough & Ready*.	Barksdale, Cook & Co.	"	1050	....	11.5	"	
43	Bear Spring.......	Woods, Lewis & Co.	"	885	....	....	"	This furnace is now extinct.
44	Dover No. 2*......	" "	"	....	....	....	"	New, on old site; in blast '55.
45	Union*..............	Standfield & Kimbble.	"	550	....	....	"	New furnace.
46	Ashland*...........	....	"	1200	....	....	"	
47	La Grange*........	Cobb, Phillips & Co.	"	1910	....	....	"	
48	Eclipse*	" "	"	641	....	4	"	New furnace.
49	Clark*...............	Broaddus, Vaughn & Co.	"	585	....	4	"	New furnace.

* Blast created by *steam*-power; that of the others by *water*-power. Nos. 15 and 20 are *hot blast;* the others *cold blast.*

The whole amount of cast-iron produced in 1854 was 40,306 tons, (2268 lbs. to the ton,) of which 1433 were castings. At a few of the furnaces other castings, to a limited amount, were made for local use; such are included with the pig-metal.

The production of our furnaces this year (1855) will be considerably above what it was last. That of the coming year, (1856,) we expect to amount to at least 50,000 tons.

94. TABLE OF THE BLOOMARIES, INCLUDING THE NUMBER OF FIRES, PRODUCTS IN 1854, ETC.

(a) *Eastern Iron Region.*

COUNTY.	No. of Forges.	No. of fires.	1854. Fires used.	1854. Tons of bar-iron made.	REMARKS.
Johnson	14	26	26	367	All use brown hematite.
Carter.........	5	10	10	168	B. hem. mostly; also magnetite & r. h.
Sullivan	2 ?	4 ?	4 ?	30 ?	R. hem. See table of refineries & note.
Washington..	2	4 ?	4 ?	55	One, cinder & b. hem., the other b. h.
Greene........	6	9 ?	7 ?	95	Brown hematite.
Sevier.........	1	1	1	2	" "
Blount	1	1 ?	1 ?	12	" "
McMinn......	1	1	1	13	Dyestone. (See § 60.)

(b) *Dyestone Region.*

COUNTY.	No. of Forges.	No. of fires.	1854. Fires used.	1854. Tons of bar-iron made.	REMARKS.
Hancock......	1	1	....	....	When operating uses dyestone.
Claiborne	8	5	4	90	Dyestone, sometimes with br. hem.
Campbell.....	5	10	5	105	" " "
Anderson	?	?	....	....	Several old forges, not operating.
Roane.........	1	1	1	7	Dyestone.
Rhea	5	10 ?	10 ?	55 ?	"

(c) *Western Iron Region.*

COUNTY.	No. of Forges.	No. of fires.	1854. Fires used.	1854. Tons of bar-iron made.	REMARKS.
Lawrence	8	8	8	80	
Warren	1	1	1	11	
Total........	51	87	78	1090	2240 lbs. to the ton.

So far as we have been able to ascertain, this table includes all the *working bloomaries* in the State. There are other old blooming forges which have gone partly or entirely down. Some of them in the Western Region have been converted into refineries.

It is proper to state that most of the bloomaries in the table were not in operation more than half of 1854, owing to the unusually low stage of water in the streams—all of them deriving their blast from water-power.

95. TABLE OF THE REFINERIES, INCLUDING THEIR FIRES, PRODUCTS IN 1854, ETC.

(a) *Eastern Region.*

COUNTY.	No. of forges.	No. of fires.	OPERATIONS OF 1854. Fires used.	Tons of blooms made.	Tons of bar-iron.	REMARKS.
Carter*.......	3	5 ?	2 ?	....	20 ?	Most likely more iron made.
Sullivan†.....	2 ?	8 ?	6 ?	....	75 ?	
Washington..	1	5	5	480	....	Pleasant Valley Works.
Monroe	1	2	2	....	75	In 1855, working old cinder.
(b) *Western Region.*						
Davidson‡ ...	2	10	5	600	....	One not operating in 1854.
Dickson‖	1	6	4	140	20	One run-out fire besides.
Montgom'ry§	5	23	17	2900	....	Three steam-forges.
Stewart.......	2	14	14 ?	3068	....	Both steam-forges.
Humphreys¶	1	4 ?	4 ?	100 ?		
Hickman.....	2	2 ?	....	....	....	Formerly bloomaries.
Total........	20	79	59	7288	190	

A ton of blooms in the Western Iron Region is 2464 lbs. It may be that the 480 tons made at the Pleasant Valley Works were estimated at 2240 lbs. per ton; if so, the *total amount* will be reduced to 7244 *bloom* tons. The bar-iron is estimated at 2240 lbs. to the ton.

The table gives *less* than the actual production of 1854. It has

* Product of one small forge not included.

† There are *four* forges altogether in Sullivan, making in 1854 about 105 tons of bar-iron. Our information is not sufficiently definite to enable us to separate satisfactorily the *refineries* and *bloomaries;* in fact, some of them have both refining and blooming fires.

‡ One did not operate in 1854.

‖ Operated but part of the year.

§ Having no statistics from the Tennessee forge, in Montgomery, its fires, products, etc., are not included.

¶ This forge did some work in 1854. We have not been able to procure the necessary items in regard to it.

been almost impossible to get the necessary information from some of the forges.

Between 2000 and 3000 tons of the blooms were converted into manufactured iron by the Cumberland Rolling-Mill in 1854; the remainder was mostly sold in Cincinnati—some in Pittsburgh.

96. TENNESSEE ROLLING-MILLS—THEIR PRODUCTION, ETC.

There are *three* rolling-mills in the State; two in East and one in Middle Tennessee.

1*st*. *Pleasant Valley Rolling-Mill*, in Washington—R. L. Blair & Brothers. Manufactured, in 1854, 480 tons of blooms into nails. This rolling-mill, as before stated, is connected with a furnace and forge, all located at the same point on the Nolichucky. The works are driven by a splendid water-power.

2*d*. *The Rolling-Mill at Loudon*, in Roane—Samuel M. Johnson & Co. Operated on a limited scale in 1854. Amount of products not known.

3*d*. *Cumberland Rolling-Mill*, in Stewart—Woods, Lewis & Co. Product in one year, from October, 1853, to October, 1854, 2223½ tons of manufactured iron, which was distributed about as follows: 1000 tons to Memphis, Vicksburg, and New Orleans; 800 tons sold in Nashville; 423 tons sold at the works, and consumed in Kentucky and Western Tennessee.

Two furnaces—Bellwood and Bear Spring*—and a refinery, with eight fires—all steam-power establishments—are connected with this rolling-mill. Their respective products, for the time specified above, are: pig-metal, 3241½ tons; blooms, 2068½ tons; manufactured iron, 2223½ tons.

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this copper region, we take the liberty of quoting the following interesting letter, written by Mr. John Caldwell, at the request of Dr. Proctor:*—

"GENTLEMEN:—I came to Ducktown in 1849, scouting for copper, and found some five or six tons in a cabin, ten feet square, on the property now known as the Hiwassee. I found the country unexplored—the school section, a property now worth a million of dollars, attracting little or no attention. Sat down in the woods for three hours, to mature a plan to control and open the section. I owned, at the time, one twenty dollar bill. After three hours' reflection, resolved to call a meeting of the citizens of the township, and make a speech explanatory of the value of the school section, and of the importance of leasing it for mining purposes. Told the people that as soon as the mines could be opened, their condition would be improved, and that civilization, intelligence, comfort, and wealth would be the inevitable results. At the conclusion of this remark, a speaker arose in the crowd, and informed me that a large portion of the inhabitants had come here to get away from civilization, and if it followed them, they would run again. After the speech was made, drew up a memorial to the Legislature, praying the passage of a law authorizing the commissioners to give a mining lease on the school section. The memorial was signed by a majority of the citizens, and, on personal application, the law was passed, and under it the lease was taken. In May, 1850, commenced mining in the woods. In the same year sunk two shafts, and obtained copper from both of them. The excavations made did not exceed twelve feet—at that depth the copper being found. Commenced mining at the Hiwassee mine in 1851, in connection with S. Congdon, the agent of the Tennessee Mining Company. Built a double cabin, and taught Sabbath-school in the kitchen end of the establishment, aided by young Mr. Walter Congdon."

In regard to the road down the Ocoee, of which we have already spoken, (see § 100,) he says: "While this same miner"—one who had

* Southern Journal, vol. iii., page 43.

spoken irreverently of their laudable Sabbath-school efforts—"was planning a way to pack the copper ore out of the mountains on mules, I surveyed the Ocoee River, and determined to make a road eighteen miles through an impassable desert. I had no means, but a strong determination to surmount every obstacle. Going to a Methodist camp-meeting, I obtained permission to make a road speech in the recess of Divine service. The speech over, we took up a collection, principally on credit and payable in trade. This, however, served the purpose; and on the 6th of October, 1851, the work was commenced. On the first day, three hands worked; on the second, two; and the third, worked *alone*—public opinion, strong and powerful, being against the enterprise. On the fourth day, hired a dozen Cherokees. Thus began one of the most important projects in the State, which was consummated in two years, at an expense of about $22,000. The Tennessee Company came early to help in the enterprise, but the Hiwassee held back till fourteen miles of the road were passable for wagons. At the close of the first year, Robert McCampbell was employed as the engineer of the road, after which I again turned my attention to mining."

105. As a continuation of this historical sketch, we append the following table of the mines, made out the last of September, 1855.

No.	Name of Mine.	When opened.	By whom.
1	Hiwassee................	August, 1850.	T. H. Callaway.
2	Cocheco................	October, "	J. V. Symons.
3	Tennessee..............	October, 1851.	John Caldwell.
4	Polk County............	November, 1852.	" "
5	Cherokee...............	December, "	Samuel Congdon.
6	Eureka.................	April, 1853.	John M. Dow.
7	East Tennessee.........	June, "	Capt. J. Tonkin.
8	Isabella...............	July, "	C. A. Proctor.
9	Hancock*..............	Sept. "	Capt. J. R Pill.
10	Mary's................	" "	C. A. Proctor.
11	Callaway...............	Nov. "	" "
12	Culchote...............	February, 1854.	William Bunter.
13	United States..........	August. "	Capt. Williams.
14	Biggs..................	" "	William Mayfield.

* Or London.

106. *The Geological Character of Ducktown and Vicinity.*—The triangular space which includes the mines, and of which we have spoken, (§ 98,) is mostly made up of a slaty rock called *mica-schist* or *mica slate*,* the layers of which *dip* or incline at a great angle, more or less towards the south-east, their *outcropping* edges ranging in consequence about north-east and south-west. It is among these layers that the copper veins lie, dipping as they dip, and appearing in outcropping lines along the surface as they do.†

In going from the mines down the Ocoee, the mica-slate series terminates when we reach the *narrows*. Here commences a splendid section of conglomerate and half-metamorphic *chlorite* and clay slates, all interstratified for miles. (§ 99.) These continue most of the way through the mountains, the gray sandstones and quartzose rocks of Formation III. finally appearing along their western flanks. After passing the mountains, the limestones and shales of the valley are met with.

107. *The Copper Veins.*—Within an area not more than six miles long and half as wide, there are at least *seven* or *eight* distinct and remarkable veins, and the probability is that there are others in the same region and vicinity yet undeveloped.‡ These veins are of various lengths; some of them are continuous for several miles; and are generally parallel. Their location, course, extent, etc., are best seen by referring to the map, on which, in a general way and according to the best data we could collect, their outcrops are traced.

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* In addition to the mica slate above mentioned, *talcose slates* and layers of tough *hornblende* rock occasionally occur, interstratified with the rest. Veins of quartz running across the strata are quite common.

† This arrangement of the layers or strata, and their included veins, may be illustrated by placing a book, containing, say, a few plates, in a highly inclined position, with its back resting upon a table, and its front edge up. If now its inclination be directed towards the south-east, or, in a word, if the book be so placed that water will run down its side in that direction, its inclination or dip, and that of its leaves, will be the same as that of the slates under consideration. The latter will be represented by the leaves, while the copper veins will have their counterparts in the few thicker sheets devoted to the plates.

‡ Since the above was written, we have been informed by a gentleman, whose authority cannot be questioned, that another vein has very recently been discovered, a few miles west of any hitherto known.

94. TABLE OF THE BLOOMARIES, INCLUDING THE NUMBER OF FIRES, PRODUCTS IN 1854, ETC.

(a) *Eastern Iron Region.*

COUNTY.	No. of Forges.	No. of fires.	1854. Fires used.	1854. Tons of bar-iron made.	REMARKS.
Johnson	14	26	26	367	All use brown hematite.
Carter.........	5	10	10	168	B. hem. mostly; also magnetite & r. h.
Sullivan	2 ?	4 ?	4 ?	80 ?	R. hem. See table of refineries & note.
Washington..	2	4 ?	4 ?	55	One, cinder & b. hem., the other b. h.
Greene........	6	9 ?	7 ?	95	Brown hematite.
Sevier.........	1	1	1	2	" "
Blount	1	1 ?	1 ?	12	" "
McMinn......	1	1	1	13	Dyestone. (See § 60.)
(b) *Dyestone Region.*					
Hancock......	1	1	....	....	When operating uses dyestone.
Claiborne	3	5	4	90	Dyestone, sometimes with br. hem.
Campbell.....	5	10	5	105	" " "
Anderson	?	?	....	....	Several old forges, not operating.
Roane.........	1	1	1	7	Dyestone.
Rhea	5	10 ?	10 ?	55 ?	"
(c) *Western Iron Region.*					
Lawrence	3	3	3	80	
Warren	1	1	1	11	
Total........	51	87	78	1090	2240 lbs. to the ton.

So far as we have been able to ascertain, this table includes all the *working bloomaries* in the State. There are other old blooming forges which have gone partly or entirely down. Some of them in the Western Region have been converted into refineries.

It is proper to state that most of the bloomaries in the table were not in operation more than half of 1854, owing to the unusually low stage of water in the streams—all of them deriving their blast from water-power.

95. TABLE OF THE REFINERIES, INCLUDING THEIR FIRES, PRODUCTS IN 1854, ETC.

(a) *Eastern Region.*

COUNTY.	No. of forges.	No. of fires.	OPERATIONS OF 1854.			REMARKS.
			Fires used.	Tons of blooms made.	Tons of bar-iron.	
Carter*.......	3	5 ?	2 ?	....	20 ?	Most likely more iron made.
Sullivan†.....	2 ?	8 ?	6 ?	....	75 ?	
Washington..	1	5	5	480	....	Pleasant Valley Works.
Monroe	1	2	2	....	75	In 1855, working old cinder.

(b) *Western Region.*

COUNTY.	No. of forges.	No. of fires.	Fires used.	Tons of blooms made.	Tons of bar-iron.	REMARKS.
Davidson‡ ...	2	10	5	600	....	One not operating in 1854.
Dickson‖	1	6	4	140	20	One run-out fire besides.
Montgom'ry§	5	23	17	2900	....	Three steam-forges.
Stewart.......	2	14	14 ?	3068	....	Both steam-forges.
Humphreys¶	1	4 ?	4 ?	100 ?		
Hickman.....	2	2 ?	....	....	....	Formerly bloomaries.
Total........	20	79	59	7288	190	

A ton of blooms in the Western Iron Region is 2464 lbs. It may be that the 480 tons made at the Pleasant Valley Works were estimated at 2240 lbs. per ton; if so, the *total amount* will be reduced to 7244 *bloom* tons. The bar-iron is estimated at 2240 lbs. to the ton.

The table gives *less* than the actual production of 1854. It has

* Product of one small forge not included.

† There are *four* forges altogether in Sullivan, making in 1854 about 105 tons of bar-iron. Our information is not sufficiently definite to enable us to separate satisfactorily the *refineries* and *bloomaries;* in fact, some of them have both refining and blooming fires.

‡ One did not operate in 1854.

‖ Operated but part of the year.

§ Having no statistics from the Tennessee forge, in Montgomery, its fires, products, etc., are not included.

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been almost impossible to get the necessary information from some of the forges.

Between 2000 and 3000 tons of the blooms were converted into manufactured iron by the Cumberland Rolling-Mill in 1854; the remainder was mostly sold in Cincinnati—some in Pittsburgh.

96. TENNESSEE ROLLING-MILLS—THEIR PRODUCTION, ETC.

There are *three* rolling-mills in the State; two in East and one in Middle Tennessee.

1*st*. *Pleasant Valley Rolling-Mill*, in Washington—R. L. Blair & Brothers. Manufactured, in 1854, 480 tons of blooms into nails. This rolling-mill, as before stated, is connected with a furnace and forge, all located at the same point on the Nolichucky. The works are driven by a splendid water-power.

2*d*. *The Rolling-Mill at Loudon*, in Roane—Samuel M. Johnson & Co. Operated on a limited scale in 1854. Amount of products not known.

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In regard to the road down the Ocoee, of which we have already spoken, (see § 100,) he says: "While this same miner"—one who had

* Southern Journal, vol. iii., page 43.

spoken irreverently of their laudable Sabbath-school efforts—"was planning a way to pack the copper ore out of the mountains on mules, I surveyed the Ococe River, and determined to make a road eighteen miles through an impassable desert. I had no means, but a strong determination to surmount every obstacle. Going to a Methodist camp-meeting, I obtained permission to make a road speech in the recess of Divine service. The speech over, we took up a collection, principally on credit and payable in trade. This, however, served the purpose; and on the 6th of October, 1851, the work was commenced. On the first day, three hands worked; on the second, two; and the third, worked *alone*—public opinion, strong and powerful, being against the enterprise. On the fourth day, hired a dozen Cherokees. Thus began one of the most important projects in the State, which was consummated in two years, at an expense of about $22,000. The Tennessee Company came early to help in the enterprise, but the Hiwassee held back till fourteen miles of the road were passable for wagons. At the close of the first year, Robert McCampbell was employed as the engineer of the road, after which I again turned my attention to mining."

105. As a continuation of this historical sketch, we append the following table of the mines, made out the last of September, 1855.

No.	Name of Mine.	When opened.	By whom.
1	Hiwassee................	August, 1850.	T. H. Callaway.
2	Cocheco..................	October, "	J. V. Symons.
3	Tennessee..............	October, 1851.	John Caldwell.
4	Polk County............	November, 1852.	" "
5	Cherokee................	December, "	Samuel Congdon.
6	Eureka..................	April, 1853.	John M. Dow.
7	East Tennessee........	June, "	Capt. J. Tonkin.
8	Isabella..................	July, "	C. A. Proctor.
9	Hancock*...............	Sept. "	Capt. J. R Pill.
10	Mary's..................	" "	C. A. Proctor.
11	Callaway................	Nov. "	" "
12	Culchote................	February, 1854.	William Bunter.
13	United States..........	August. "	Capt. Williams.
14	Biggs....................	" "	William Mayfield.

* Or London.

106. *The Geological Character of Ducktown and Vicinity.*—The triangular space which includes the mines, and of which we have spoken, (§ 98,) is mostly made up of a slaty rock called *mica-schist* or *mica slate,** the layers of which *dip* or incline at a great angle, more or less towards the south-east, their *outcropping* edges ranging in consequence about north-east and south-west. It is among these layers that the copper veins lie, dipping as they dip, and appearing in outcropping lines along the surface as they do.†

In going from the mines down the Ocoee, the mica-slate series terminates when we reach the *narrows.* Here commences a splendid section of conglomerate and half-metamorphic *chlorite* and clay slates, all interstratified for miles. (§ 99.) These continue most of the way through the mountains, the gray sandstones and quartzose rocks of Formation III. finally appearing along their western flanks. After passing the mountains, the limestones and shales of the valley are met with.

107. *The Copper Veins.*—Within an area not more than six miles long and half as wide, there are at least *seven* or *eight* distinct and remarkable veins, and the probability is that there are others in the same region and vicinity yet undeveloped.‡ These veins are of various lengths; some of them are continuous for several miles; and are generally parallel. Their location, course, extent, etc., are best seen by referring to the map, on which, in a general way and according to the best data we could collect, their outcrops are traced.

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* In addition to the mica slate above mentioned, *talcose slates* and layers of tough *hornblende* rock occasionally occur, interstratified with the rest. Veins of quartz running across the strata are quite common.

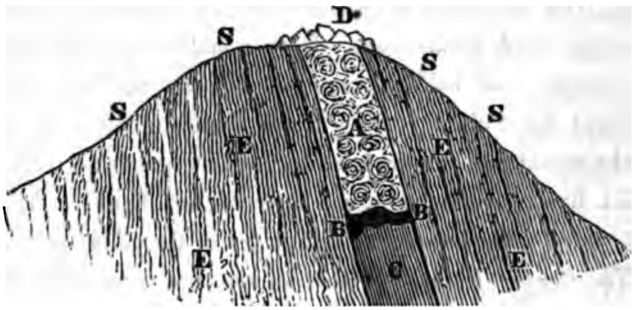
† This arrangement of the layers or strata, and their included veins, may be illustrated by placing a book, containing, say, a few plates, in a highly inclined position, with its back resting upon a table, and its front edge up. If now its inclination be directed towards the south-east, or, in a word, if the book be so placed that water will run down its side in that direction, its inclination or dip, and that of its leaves, will be the same as that of the slates under consideration. The latter will be represented by the leaves, while the copper veins will have their counterparts in the few thicker sheets devoted to the plates.

‡ Since the above was written, we have been informed by a gentleman, whose authority cannot be questioned, that another vein has very recently been discovered, a few miles west of any hitherto known.

Some of these, or allied veins, are also found in the same range in Georgia, and perhaps, too, to the north-east in North Carolina; but the most valuable, so far as known, are included in the region under consideration.*

108. They are all remarkably similar in character.† The following section‡ will illustrate their mode of occurrence, extent, etc.

SECTION OF A DUCKTOWN COPPER VEIN.



S, S, S, surface of the ridge intersected. E, E, E, mica slate. A, B, B, and C, the vein. D, "gossan" on the surface.

109. It will be seen that the vein is composed of *three distinct portions.*

The *upper part*, A, is a heavy mass of light porous *iron-ore*—an

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* No reference is here made to the mines of Carroll, etc., in Virginia.

† They are called by some *segregated* veins, meaning thereby, that the great sheets which compose them have been formed by the gradual separation and concentration of mineral matter originally diffused through the surrounding formations. We shall take another occasion to speak of this.

‡ It is very desirable that a clear idea should be obtained of what a *section* is, and of its use in geology. In the first place, the face of a perpendicular bluff or cliff—just such as occur along our rivers—presents a *natural section*, exhibiting the character of the strata which compose the bluff. The edges of the rocks are exposed along its face, and indicate at once the order, thickness, kind, and often the position, as to whether horizontal or inclined, of the strata in the hill, ridge, or upland immediately back, and of which the bluff forms a part. An *artificial* section of any hill, ridge, plain, basin, etc., is the representation of the rocks or strata *as they would appear* were they exposed in the face of a bluff running across or through such hill, ridge, etc.

For example, we have in the section above a representation of a supposed bluff, made by cutting through one of the ridges containing a copper vein. So, too, in the

impure hydrated peroxyd—to which the miner's term *gossan* is universally applied. This is the material that Mr. Duggar (see § 103) attempted to work in his forge. The *gossan* is found at many points along the outcrops of the veins, especially on the knolls and ridges. Sometimes it occurs in great banks or blocks, scattered over a space fifty or a hundred feet wide. In the section, D represents the surface-gossan.

110. The *portion* B, B, is a *bed* or mass of dark or black copper-ore—an impure *black oxyd*—some of it containing as high as fifty per cent. of metallic copper, but averaging from sixteen to twenty. At some points, the ore is mixed, more or less, with fragments of *quartz* and *iron pyrites*.

This bed has furnished as yet all the ore shipped from the mines. Its vertical thickness is variable: at some points it swells out in great masses many cubic yards in volume; then again it becomes a thin, irregular layer. The average, perhaps, is between two and three feet. In width, of course, it varies with the veins; these, at some points, are fifty and sixty feet wide—the average, however, being much lower. Its distance from the surface is also variable, and dependent in part upon topographical features. On high ground it is often from seventy to ninety feet; in the valleys, much less—perhaps about twenty-five. The distance appears to be the same as that of the *water-level;* in other words, to be the same as that to which it is necessary to go—in digging wells, for example—to reach water.

111. The *lowest part*, C, *which runs down indefinitely*, is a hard "arsenical" rock, so-called, containing iron, sulphur, and generally a variable per centage of copper in the form of sulphuret. It often, too, encloses quartz and fragments of mica slate.

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general section at the bottom of the map accompanying the report, we have, in a word, the face of an exposed bluff running entirely through the State.

These sections are constructed from data collected by travelling over the line of country to be represented, and by carefully observing, at the same time, the character of the rocks as they successively appear on the surface, as, for instance, the edges of the strata cropping out on the hillsides, or in the valleys, etc.

The vein was once undoubtedly filled to the top with this material. The gossan and the *black oxyd* have been derived from its decomposition, which has taken place mainly, as we think, through the action of water. The original "arsenical" ore, in the slow progress of its decomposition downwards, has left behind the resulting light porous gossan. The heavier black oxyd, on the other hand, in some form or other, has been constantly carried downward, until it has formed, resting immediately upon the undecomposed mass, the bed of black ore, as we now find it.*

112. Although the amount of the *black oxyd* is great, yet, as may be inferred from the mode of its occurrence, it is not *inexhaustible.* Many, stopping here, have put too low an estimate upon the value of these mines. They have conceived that when *this* bed of ore shall have been exhausted, the mines will be worthless. This is doubtless a great mistake. Their value in fact depends upon the richness of the lower part of the veins. To determine this—to know how rich in copper the so-called arsenical rock may be, has been an important question, which so far has been answered favorably. Several shafts have been sunk with a view of testing this matter, the results of which thus far have been very satisfactory. Capt. Harris, in the Third Annual Report of the Hiwassee Company, says: "At the depth of one hundred and forty-two feet from the surface, or sixty feet below our adit level, I have another cross-cut of sixty-four feet, at which point I have cut the lode, where we have a fine bunch of yellow sulphuret exposed to view. I have not as yet struck the foot wall. The farther I get into the lode, the better it proves to be. I am at present in the lode five feet; if it continues to improve, it will surpass any thing I ever saw." We look confidently for the most favorable results from these test shafts.†

* Perhaps the decomposition of the original matter has furnished soluble salts of copper, which, coming in contact again with the same matter under *different conditions*, have themselves been decomposed, and the oxyd precipitated. A very intelligent gentleman, connected with the mines, assures us that he has observed such decompositions as the latter.

† Since writing the above, we have received additional and interesting information.

113. *Present Production of the Mines.*—The following table gives the product and the condition of the mines for the month of September, 1855; also, the per centage of the last ore sold, and the points where sold.

No.	Name.	Pounds produced in Sept. 1855.	Value per cent. of ore last sold.	Where sold.
1	Hiwassee..............	269,174	24	New York.
2	Cocheco*..............			
3	Tennessee............	217,641	26	Baltimore.
4	Polk County..........	254,172	29½	London.
5	Cherokee†			
6	Eureka.................	281,714	23¾	Boston.
7	East Tennessee†			
8	Isabella................	279,614	29	London.
9	Hancock..............	239,716	41	"
10	Mary's.................	267,146	36	"
11	Callaway†			
12	Culchote‡.............			
13	United States†.......			
14	Biggs†			

According to the table, seven of the mines produced in September, 1855, 1,809,177 lbs., or a little more than 807½ tons. Though we have not the facts necessary to determine accurately, yet the value of this ore is perhaps about $80,000.

114. We add, on the following page, another table, showing the present extent of the operations, and the entire amount of ore shipped from the mines since their first opening.

It will be seen that eight mines have produced and shipped 14,291 tons, worth more than a million of dollars. The Hiwassee alone has shipped 4156 tons—about two-sevenths of the whole.

Capt. Harris reports as follows: "The vein has been intersected by a cross-cut sixty feet lower, being two hundred feet from the surface. At this depth it has *greatly improved.* Masses of fine yellow sulphuret occur in abundance. This is considered as settling the value of the mines."

We have had the pleasure, within a few days back, of seeing elegant specimens of the sulphuret taken from the part of the vein referred to, which promise well for its future.

* In U. S. Court. † In market. ‡ Opening dead ground.

No.	Name.	Tons shipped.	Feet of shafts.	Drivage in feet.
1	Hiwassee	4156	641	2784
2	Cocheco	....	98	74
3	Tennessee	7355	472	1161
4	Polk County		847	1841
5	Cherokee		385	1147
6	Isabella		217	711
7	Mary's		189	197
8	Eureka	1100	180	872
9	Hancock	1680	264	742
10	East Tennessee	....	191	640
11	Callaway	....	100	147
12	Culchote	....	207	289
13	United States	....	114	100
14	Biggs	....	70	14

115. The want of a railroad from the mines to some convenient point on the East Tennessee and Georgia road has *seriously* affected their production. With the proper facilities for transportation, the amount shipped would be *vastly increased.*

In view of all the facts, we feel justified in regarding these mines as of great value, and think their full development well worthy of all the encouragement the State may give.

Other Localities of Copper, etc.

116. Copper ores have been discovered at several points in East Tennessee out of Ducktown, but not as yet, so far as we know, in sufficient quantity to justify mining operations.

There are two localities, one in Monroe and another between Clinch Mountain and Copper Ridge, in Grainger, where small quantities of the carbonates of copper occur in limestone. At the latter place, too, a little sulphuret is found, associated with iron pyrites.

Some green carbonate has been found on the waters of the Tellico and Cane Creek, in Monroe.

At many points, along the whole range of the Unaka Mountain group, traces of copper are found, generally associated with iron

pyrites; but no locality of importance has, so far, come under our observation.

117. *Where to look for Copper.*—The first two formations in the Tennessee series are, above all others in the State, *metalliferous.* Within the region occupied by these, metallic veins may, with good reason, be looked for.*

118. The *Mica Slate Group*—the first in the series†—is, as before implied, (§ 106,) the formation in which the Ducktown veins occur. For the most part, this group runs into North Carolina; nevertheless, it reaches at several points into Tennessee, covering extensive areas. The largest of these commences in the south-eastern part of Washington, and runs north-eastward through Carter and Johnson. *Crab Orchard,* in the former county, affords a large extent of this formation, and offers an inviting field for exploration. The entire range of the Mica Slate Group, so far as found in Tennessee, can at once be made out by reference to the map.

119. The most of this metalliferous region, however, is occupied by the great bed of *talcose* and *semi-micaceous slates* and *conglomerate,* which constitute Formation II.† This series covers a portion of Polk, and mostly the mountain parts of Monroe, Blount, Sevier, and Cocke. Some copper has already been found in it, and we can see no reason why valuable deposits may not exist within its range. The general indications are favorable. As we shall see hereafter, it has so far furnished all the gold found in Tennessee. The range and extent of this formation, as in the last case, can be seen upon the map.

Attention to the characters presented by the Ducktown veins,

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* We do not wish to be understood, in what is said here or elsewhere, as encouraging a wild, random search for "minerals," to the neglect of business, etc. We would far rather control and discourage, than be the cause of originating any such spirit. Those, however, who are accidentally thrown into mineral regions—the hunter, the traveller, the surveyor, etc.—can easily, without any sacrifice, keep a lookout for traces of outcropping veins. It will be well for such to do so in the region under consideration.

† See Chapter VI.

especially to those connected with their outcrops along the surface, or to the "surface indications," is recommended to those who may have occasion to explore the wild regions occupied by either of these formations.

SECTION III.

LEAD AND ZINC.

120. But little has yet been done towards the development of the *lead* and *zinc* of Tennessee. Ores of these metals occur at numerous points. The localities are more or less important, and many of them deserve attention. We will first enumerate the different species of ores occurring, so far as we have observed, within the State.

121. *The Ores of Lead and Zinc found in Tennessee.*—There are *five* in all, two of which, however, are of little importance.

1*st.* *Sulphuret of Lead, or Galena,* which, when pure, contains in 100 parts,

Lead	86·66
Sulphur	13.34
	100·00

It may be recognized by its metallic lustre and *lead color*, together with its crystalline, or sometimes granular structure. With the exception of the one below, it is the only lead ore that we have seen in Tennessee.

2*d.* *Carbonate of Lead, or White Lead Ore,* called also *Cerusite.* It is composed, when pure, in 100 parts, of

Lead	77.70
Oxygen	5·90
Carbonic Acid	16·40
	100·00

We know of but one locality of this species, of which we will speak farther on.

3d. *Sulphuret of Zinc, or Zinc Blende,* sometimes called "*Black Jack.*" Its composition is,

Zinc	66·90
Sulphur	33·10
	100·00

This mineral, which can scarcely be regarded as an ore, has a yellowish, or brownish-yellow color, with a waxy lustre. It is often crystalline, and sometimes massive.

4th. *Carbonate of Zinc, or Smithsonite,* sometimes called *Calamine,* composed of

Oxyd of Zinc	64·81
Carbonic Acid	35·19
	100·00

The color is impure white, or brownish. It is distinguished from the following mineral by its effervescing with acids.

5th. *Silicate of Zinc, or Calamine.* Its composition is,

Silica	25·10
Oxyd of Zinc	67·40
Water	7 50
	100·00

Its color is generally whitish or yellowish.

The last two minerals have little of the aspect of ores, and would escape the attention of one not acquainted with them. They occur massive or incrusting; sometimes in mammillated or stalactitic forms; often as earthy or stony masses of yellowish-gray colors. As a general thing, they may be distinguished by coarsely pulverizing them and throwing the powder upon burning charcoal; if zinc be present, a white cloud of oxyd will arise, and may be collected on a cold plate of iron held over the fire. The weight, too, sometimes gives a useful hint as to their nature.

122. *Lead in East Tennessee.*—There is scarcely a county in East Tennessee that does not afford more or less galena. At all the localities which we have visited, it is found in the limestones of

Formation IV.* In Marion and Bledsoe it occurs in the Mountain Limestone. It is very frequently associated with zinc blende, and is found,

1st. *In thin seams or veins, from one to twenty inches in thickness, occupying fissures in the rocks ;* and,

2d. *In small patches or pockets, or in grains, disseminated through limestone.*

123. In Claiborne county there are numerous veins which have attracted attention, and upon which several shafts have been sunk. Generally they are thin seams of galena and blende, with a flinty veinstone.

An important one, and, by the way, the best we have seen in the State, occurs on Powell's River, between Tazewell and Jacksboro', about sixteen miles from the former place. The vein fills a nearly vertical fissure, about twenty inches wide, in rocks which dip but little. It can be traced for a mile or more. At the time of our visit, July of this year, (1855,) very little had been done towards its development, but its character, in one place on the surface, could be distinctly seen. The galena, associated with blende, occurs in several sheets, with an aggregate thickness of about five inches. The sheets are separated by a gray flinty veinstone. There is reason to believe that the character of the lode will improve farther down. The property belongs to Messrs. Caldwell, Birdseye, and others, who were making arrangements to test its value.

In Johnson, south of the Watauga, on the Duggar property, there appears to be a vein of galena with blende. It has not been sufficiently exposed, however, to enable us to form an opinion of its character.

A vein of galena in Monroe, said to be valuable, has been reported. We have not had an opportunity of visiting the locality.

124. Deposits of the second class are numerous. None of them appear to be of much importance.

We have already spoken of the lead and zinc in the iron ores of

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* See Chapter VI.

Bompass Cove, and in those used at Carter's furnace, in Carter county. (§ 55.) These, no doubt, have been derived from galena and blende, liberated by the leaching of the limestones beneath the iron banks. In fact, at some points in Bompass Cove, the limestone can be seen charged more or less with grains and bunches of these ores. At one point some work has been done, in expectation of meeting with a valuable deposit of galena.

In this connection we may add, that the coves and valleys of the north-eastern counties will yet, in all probability, afford deposits or veins that may be profitably worked.

125. Several years ago some lead was raised in Jefferson, but we know nothing as yet of the mode of its occurrence.

The *carbonate of lead*, spoken of above, is found in Greene county, on the road to the Warm Springs, and in the trough of Meadow Creek and Paint Mountains. It occurs in small gray pieces, scattered through the soil. The rocks below had not been sufficiently exposed, when we were there, to show the character of the locality.

126. The limestone constituting the base of the Cumberland Tableland, which lies both in East and Middle Tennessee, affords some lead at several points. A vein of some interest occurs in Marion county; other localities are in the sides of the mountain above Sequatchee valley; lead, too, has been found in White, in the "Gulf of Caney Fork," etc.

Lead has been reported at many other points in East Tennessee. Hereafter we will endeavor to visit and report upon them. Much remains to be done in this part of the State, in reference to the development of the true character and value of its lead ores.

127. *Lead in Middle and West Tennessee.*—Veins of galena, generally associated, as in the Eastern Division, with blende, occur in many counties in Middle Tennessee. Most of them are of but little importance; several, however, promise to be of some interest. Our investigations are, at this early day in the work before us, too incomplete to give a satisfactory account of them. We prefer to retain what facts we have until opportunities are afforded for further examinations.

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128. In regard to a "large vein" in Davidson, in the vicinity of Haysborough, Dr. Troost, in his seventh report, says: "It is very probable that this vein is very extensive and rich, and the ore is good. It has been penetrated about ten or twelve feet, and has already, at this inconsiderable depth, produced about 1000 lbs. of lead. This vein being situated near a rivulet, the work was impeded by the water, and the operation abandoned. By an accurate search, the same vein may be found at a more convenient place; or by erecting pumps, the vein may, perhaps, be worked with advantage. It is very probable, as I mentioned above, that this vein is extensive; traces of it are found on the bank of the Cumberland River in several places." This galena, associated with some zinc blende, occurs in a *gangue** *of sulphate of baryta.* It is not at present in a condition to admit of examination.

129. Some lead ore has been reported as occurring in the limestones of West Tennessee. Their real importance remains to be determined. Loose fragments or pebbles of galena have occasionally been noticed in the gravel-beds of the District.

130. *The Zinc of East Tennessee.*—We have already had occasion to speak of zinc blende in connection with galena. Besides this, there are veins and irregular deposits of the *carbonate of zinc* associated with more or less *silicate.* The localities are very numerous. As in the case of galena, they exist in the magnesian limestone of Formation IV.†

131. The zinc ores of *Claiborne* have been long known.‡ With the lead veins already mentioned, they occur occasionally for twelve or fifteen miles along a great *anticlinal axis*, or arch-like fold in the rocks. The diagram on page 42 exhibits a section of this fold. The ores appear to occur in gash-veins, and true fissure-veins. Many of them are thin,

* The *gangue* or *veinstone* is the non-metallic mineral matter which encloses or is associated with *the ore* in a vein.

† There is a locality near Knoxville, discovered by Dr. Montroville W. Dickeson, which *may be* in Formation V. We have not had as yet an opportunity of visiting it.

‡ To Dr. Troost is due the credit of having first called attention to the zinc of East Tennessee. The most important localities were pointed out by him.

and of limited extent; there are several, however, which are very promising. One that we have visited, at Russell's, several miles below the Caldwell and Birdseye lead vein, mentioned above, exhibits much loose ore upon the surface, and may be several feet, or perhaps yards, in width. It is well worthy of exploration. Some lead ore, too, has been found here, which may prove more abundant in descending. The vein appears to be a true fissure-vein.

This property, and in fact all of the most important zinc and lead localities in East Tennessee, have been leased by individuals and companies, and, no doubt, within a few years, will be tolerably well tested.

There are other interesting localities in Claiborne, which will be reported upon hereafter.*

132. At several points in Jefferson county, ores of zinc occur. The most important appears to be one on Mossy Creek, a few miles north-east of New Market. At this point, numerous irregular veins—most likely gash-veins—in limestone rocks, nearly horizontal, occur on a hillside, within an area of several acres. The ore is calamine and smithsonite, with occasionally blende. A few pits have lately been sunk upon them; but the work has not been sufficiently advanced to test their extent and value. The external indications are favorable. Another locality is near Dandridge.

From Mossy Creek on down through the New Market valley, and in a south-west direction, through Knox, as far as Loudon, on the Tennessee River, zinc ore is found at numerous points. At many of them the calamine, etc., exist in limited quantities; at some, however, the ore promises to be of value.

133. Localities of calamine, etc., also exist in Cocke county.

We shall, as soon as practicable, make out a list of all the localities, and add notes in regard to their value. We regard the zinc ores of East Tennessee with great interest.

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* It is with pleasure we refer to and acknowledge the kindness and many favors we received from Dr. M. Carriger, the Rev. Mr. Kelly, and other gentlemen of Tazewell, during the time we spent in Claiborne. We shall not soon forget their hospitality, and the assistance they rendered us.

In Middle Tennessee, as we have already said, zinc occurs with galena at many points, but not in sufficient quantity, so far as we know, to merit the attention of the miner.

184. *The Paint manufactured from Zinc and its Ores.*—The use of the white oxyd of zinc, as a substitute for white lead, in painting, is becoming extensive and important. It affords a fine example of one among the many contributions which chemistry has, within a few years, made to the useful arts. As we are often applied to for information in regard to zinc paint, and by way of showing the value of one article which our ores may be made to produce, we quote the following instructive paragraphs from the Mining Magazine.

WHITE OXYD OF ZINC, AND INSTRUCTIONS FOR ITS USE.

(a) *Manufacture and Uses of Oxyds.*

White oxyd of zinc has been known as far back as the last century, but to Mr. Leclaire, of Paris, we owe the discovery of the most practical method of its manufacture, and its fitness for painting. Mr. Leclaire having sold his patent right to the Vielle Montagne Zinc Mining Company, the latter alone have a right to manufacture white oxyd of zinc by the Leclaire process, both in Europe and America.*

The Various Uses of Oxyds.—The oxyds manufactured by the V. M. Company, at their extensive works in Belgium, France, and Upper Silesia, are—

1*st*, *Snow White.* A beautiful, brilliant, and most delicate white, used for fine ornamental inside painting.

2*d*, *White No.* 1. Nearly equal to snow white, used for all inside, also for outside work when required.

3*d*, *Stone Gray* (light tint). Its use is naturally inferred.

4*th*, *Dark Gray.* A semi-metallic oxyd, used for priming. It is also especially adapted for painting iron work and iron ships, which it protects most effectually against corrosion.

. . . .

Zinc Paint used for Imitation Stucco, Slates, etc.—This paint embodies itself so completely with oil, and becomes so hard, that it can be polished like stucco. A process has been discovered for using it as a water-proof cement, and also for obtaining smooth, hard and light tablets of all sizes and colors, answering all the purposes of school and office slates. Canvas for portrait painting, prepared with white zinc, has an advantage over all others, namely, that of not being acted upon by metallic colors and dampness.

* The white oxyd, or paint, is also manufactured in this country, in Pennsylvania and New Jersey. The New Jersey Zinc Company was organized in 1848. In 1853, they manufactured 1805 tons, and estimated their production for 1854 at 3570 tons. During the year 1853, the company netted a profit of $90,592 16, and paid $42,944 50 in dividends. The Pennsylvania and Lehigh Zinc Company was organized in 1853. Their works are calculated to produce ten tons of the oxyd per day. At both establishments the oxyd is manufactured directly from the ore.—*Whitney's Metallic Wealth.*

(b) *Advantages of White Zinc over White Lead.*

They consist mainly in perfect security from the usually unhealthy effects of white lead paint, in greater economy, and in permanency of color; the proofs of which rest upon numerous certificates and affidavits by public functionaries, architects, surveyors, engineers and private individuals, which are not given here for want of room.

Innocuousness.—In its manufacture from plate spelter, and in the various stages of its preparation and use as a paint, oxyd of zinc is completely innocuous, and produces none of the physical accidents to which the white lead manufacturer and painter are subject, viz., paralysis, painter's colic, and frequently death from the recurrence of those diseases; the same accidents not unfrequently affecting the occupants of recently painted dwellings. The advantage, in this respect, of zinc paint, has induced the French government to enforce its use for all public works and government contracts.

All apartments, however confined, may be painted with zinc without disturbing the inmates, who may rely on perfect safety from any bad effects upon their health; the only inconvenience felt is the usual smell of turpentine, and that in a less degree and for a shorter time than with other paints.

Economy.—The saving produced by the use of white zinc instead of white lead, may be considered as equivalent to 25 per cent. This economy is derived,

1st. From the circumstance that zinc being a much lighter body than lead, and absorbing a greater proportion of oil in the grinding and mixing, a given quantity of zinc oxyd will spread over a more extended surface, than would a similar quantity of white lead, and cover as well, if properly used.

2d. From the far greater durability of the work done with zinc. A house painted entirely with the pure V. M. zinc paint, properly mixed and laid on, and regularly washed every year with cold water, with which a small quantity of finely powdered pumice-stone has been mixed, will look as fresh for several years, after each successive washing, as if newly painted. (N. B. Soap-suds or potash should not be used for washing zinc paint.)

The following table, showing the results of various experiments made in 1850, at the Toulon navy-yard in France, is given in support of the above. The French metre and kilogramme, used in the original calculation, have been converted into the English yard and pound.

SQUARE YARDS COVERED BY ONE POUND OF ZINC AND LEAD PAINTS RESPECTIVELY.

	FIRST COAT.		SECOND COAT.		THIRD COAT.	
	Zinc.	Lead.	Zinc.	Lead.	Zinc.	Lead.
	Yds.	Yds.	Yds.	Yds.	Yds.	Yds.
On pitch or white pine, new	4.74	3.82	6.44	5.07	6.44	5.01
On " " " after scraping the old paint	2.67	2.40	5.72	3.98	5.72	3.98
On oak, " " "	2.83	2.56				
On iron, " " "	4.74	3.27				
On sheet-iron, painted the year previously with white lead	2.94	2.51				

Permanency of Color.—The permanency of color in zinc paint is very great, and none of the causes which generally destroy other paints will affect it.

Indeed, experience has proved that the exhalations and the mephitic air engendered

in and emanating from hospitals, prisons, factories, "abattoirs," theatres, water-closets, stables, cesspools, ships' holds, and confined and badly ventilated localities, have never been found in the slightest degree to affect the color and durability of good zinc paint.

In regard to the more delicate branch of portrait painting, etc., the use of snow-white oxyd of zinc, as a matter of course, tends greatly to preserve the purity of colors against any action of the atmosphere.

(c) *Practical Instructions.*

Choice of a Paint Oil.—Several kinds of oil may be used for mixing with oxyd of zinc, viz., poppy, walnut, hempseed, linseed, and even fish oil.

Of these, hempseed oil is the best, and dries the quickest; but it is seldom used, on account of its scarcity.

Poppy oil is very white, and is adapted for inside work; it requires a great proportion of dryer.

Walnut oil being subject to thicken, ought to be kept from heat and light in closed glass vessels: its use is limited on account of that natural defect.

Fish oil ought to be entirely rejected, on the score of its intolerable smell, its tenacity of moisture, and the almost certainty of its turning yellow.

Linseed oil is thicker and dries better than any other except that of hempseed: the rice is moderate, and it is in every respect the best to mix with oxyd of zinc.

Purifying and Bleaching Linseed Oil.—The process of purifying and bleaching this ildeserves to be briefly described here.

An oblong box is made about two feet deep, of plates of thick glass, fitted together, so as to be impermeable, by means of lead sash-bars and cement. This box is set up in a place exposed to the light and the rays of the sun; it is filled half with oil and half with pure water, and covered with a glass cover; the contents are stirred up and mixed together from time to time during eight or ten weeks, after which the oil will be found entirely pure, and may be drawn off with a siphon.

By this process the albumen of the oil is separated from it by the contact with the water, and settles down to the bottom of the box. The bleaching is the effect of light.

Any other process, and chiefly the use of acids, is injurious to the oil.

Grinding in Oil.—The grinding of white zinc in oil is, in the main, done by the same means as that of white lead. It may, however, be remarked, that great improvements have lately been made in the old machinery. In France and England, sets of three horizontal marble rollers are employed; in America, mills of two buhrstones, the upper one of which is balanced on the same principle as a ship's compass, and the lower one only revolves. Both systems give satisfactory results.

The proportion of oil to zinc varies between twelve and twenty-five parts of oil to eighty-eight and seventy-five parts of zinc, according to the greater or lesser power and perfection of the apparatus.

One of the advantages of white zinc over white lead is, that, while the latter must always go through the mill, the grinding of zinc can be done on a marble tablet, in the usual way, with a small additional proportion of oil.

In case of need, even simple emersion and stirring will be sufficient.

Whatever may be the mixing process, no water should be used, as this would constitute the two-fold imposition of increasing the weight and impairing the quality.

For properly using Zinc Paint.—The use of zinc paint is less laborious than that of white lead, inasmuch as, 1st, the former is lighter and requires less pressure; 2d, a day's work will not prostrate the energies of the painter, as it is well known to do

through the use of white lead, daily examples of which are unhappily but too evident to require being cited.

The work is to be prepared precisely as for lead colors. Sizing, knotting, and priming, in similar manner, except that the priming must be done with zinc paint, tinted, if required, with any coloring matter in which lead does not enter, and the work must be stopped with zinc putty before laying on the second coat.

Zinc paint, no more than lead paint, should be used immediately after being ground. It is considerably improved by being kept for a year, more or less, after grinding. The dark gray paint alone, being liable to harden, should be used whilst fresh.

Old white lead painting must be scraped off clean previous to putting on the zinc paint. To save labor, washing and scouring the same with water and potash, or pumice-stone, will suffice.

A coat of hydrofuge gray or white paint over the lead paint, and to serve as grounding for the zinc, is also most effectual, and entirely precludes the lead from affecting the durability of color of the new paint, besides effectually securing the object againstdamp.

Dryers.—No lead dryers should ever be made use of for zinc paint. There are two kinds of zinc dryers; one is prepared by boiling peroxyd of manganese in pure linseed oil, in the proportion of one pound of manganese to one gallon of oil; the other, invented and exclusively manufactured by the V. M. Company, is in the shape of an impalpable and pure white powder, similar to white oxyd of zinc.

Of the manganesed oil, from one to six per cent., and of the dryer in powder, one or one and a half per cent., should be mixed with the zinc paint in thinning.

Brushes.—It is deemed necessary here to urge the adoption by painters of proper brushes, in order to produce unobjectionable work. The brushes to be used with zinc paint should be made of white, long and fine bristles, thickly and closely set, and the finishing brush should be flat, with very fine points, in order to produce a perfectly smooth surface and even tint. The frequent cleansing of the brushes in spirits of turpentine cannot be too strongly recommended.

Old or nearly worn-out brushes, as also such in which horse-hair or whalebone has been mixed with the bristles, should be rejected.

Mixing Proportions.—Zinc paint, as it comes from the mill, is composed of—

Oxyd	75 parts.
Oil	25 "
	100 "

To prepare it for the specific purposes for which it may be wanted, it must be diluted with oil, spirits of turpentine, or varnish, in quantities varying according to the work to be done.

FOR BRILLIANT WHITE.

1st coat	Spirits of turpentine.
The others	Linseed oil.

FOR DEAD WHITE.

1st, 3d, and 4th coats	Spirits of turpentine.
2d	Spirits and a little oil.

FOR PAINTING ON PLASTER OR CEMENT, (NEW.)

1st coat.	Linseed oil	48 parts.
	Turpentine	21 "
2d coat: Flat or Graining.	Linseed oil	13 parts.
	Turpentine	11 "
3d coat: Flat—	Turpentine only	15 parts.
Brilliant or Graining.	Linseed	13 "
	Turpentine	11 "

PAINTING ON OAK, (OLD OR GREEN.)

1st coat.	Linseed oil	8	parts.
	Turpentine	13	"
2d coat.	Linseed oil	7	"
	Turpentine	11	"

3d coat: same proportions as second.

PAINTING ON DEAL, (NEW.)

1st coat.	Linseed oil	11	parts.
	Turpentine	13	"
2d coat.	Linseed oil	7	"
	Turpentine	11	"

3d coat: same proportions as second.

REPAINTING OLD WORK.

1st and 2d coats and gray colors.	Linseed oil	7	parts.
	Turpentine	11	"
Graining, ditto.	Linseed oil	12	"
	Turpentine	13	"

PAINTING ON IRON.

1st coat—Turpentine only		17	parts.
2d coat.	Linseed oil	8	"
	Turpentine	11	"
3d coat—Turpentine only		16	"

By adhering to the above proportions, and to the foregoing advice, painters will find zinc paint to give such satisfactory results, that there is no doubt they will ultimately prefer it to any other.

When the paint is to be used soon after grinding, the oxyd may be ground with twenty parts of oil instead of twenty-five, thus—

Oxyd	80	parts.
Linseed oil	20	"
	100	"

From the above stated proportions in mixing for use, the painter will find that the paint for the second and third coats will, in the paint-pot, be about the consistency of thick cream, which is the proper one. The light nature of the oxyd, and the greater fluency given to the paint by the proportions of turpentine, make it spread under the brush with great facility, covering, at the same time, perfectly well.

It is advisable to keep white zinc paint under oil rather than under water. Dark gray ground paint should not be kept too long, and never otherwise than under oil, as it is liable to harden.

. . . .

SECTION IV.

GOLD.

135. *General Extent and Character of the Gold Region.*—During the last twenty-five years, gold in limited amount has been obtained in Tennessee. The region in which it occurs lies in the south-eastern part of the State. From our own observations, we feel justified in

extending its limits beyond those hitherto assigned it. More or less gold could doubtless be found in the mountain parts of all the eastern counties, from the French Broad to Georgia, including Cocke, Sevier, Blount, Monroe, and Polk, in places—and they are very numerous—where the slates of Formation II.* assume a *semi-talcose* and a fine *semi-micaceous* character, and contain, at the same time, between their layers, or are intersected by veins of quartz.

136. Though we would not attach a factitious value to this as a gold region, and though as yet attempts at actual mining have been limited, and have not proved lucrative, yet we have good reason to believe that some of the heavy quartz veins, so abundant in many places, will—whether true or segregated veins—ultimately furnish mines which will be profitable. With a view to this, we trust hereafter to be able to make more minute examinations throughout this whole region.

The extent, range, etc., of Formation II., in which all the Tennesssee gold that we know of occurs, and in which it is likely to be found, can be best made out by referring to the general description of the formation, in Chapter VI., in connection with the map accompanying the report.

137. *Known Localities.*—There are numerous localities where this *precious* metal has been found. At most of them it occurs in small quantities. In all cases, with but one or two exceptions, it has been washed out of the gravel, sands, etc., of branches, creeks, or rivers.

The following are some of the localities: in Blount county, a few miles east of Montvale Springs, back of Chilhowee Mountain; in Monroe, at several points, as follows—on the waters of Citico Creek, in the bed of Cane Creek, on the head-waters of Tellico River, and on those of Coco or Coqua Creek; in Polk county, too, it has been found.

138. *Coco Creek and Vicinity.*—The localities which have afforded most of or nearly all the gold, are those of *Coco* Creek and vicinity, including a strip of country perhaps eight or ten miles long, and two or three wide. This region appears to be part of a long, wide, *shallow*

* See Chapter VI.

depression or trough among the mountains, and not far from the State line, running north-eastward through a good part of Monroe, and altogether perhaps fifteen or twenty miles long. This depression is distinctly seen from high points. It is intersected by the Tellico, and affords some of the important tributaries of that river. Coco Creek, a tributary of the Hiwassee, flows through the southern part.

139. *Discovery and Production in the Coco Creek Region.*—Near Coco Creek the first gold was discovered in 1831. As soon as the fact became generally known, hundreds of persons flocked to the golden field, and engaged in washing the gravel, sands, etc., of all the low places and streams, small and great, in the region. Every year since, more or less work has been done, and gold to the value of many thousand dollars has been collected and carried off. It would be impossible now to ascertain the exact amount thus obtained.

We have been informed that at first, in the richest localities, an *industrious* man could average two dollars a day, which was then, when wages were low, considered an excellent business. In a short time the average was reduced to a dollar and a half, and then to one dollar, etc.

At present some washing is occasionally done. About fifty cents a day to the hand can be depended upon, with the additional prospect of greater yields at intervals.

140. The following table shows the amount of Tennessee gold deposited at the United States Mint, and branches, from 1831 to 1853, inclusive.* It includes, no doubt, the *greater part* obtained within the State.

* The part of the table from 1831 to 1847, inclusive, has been taken from Dana's Manual of Mineralogy; the remainder, from 1848 to 1853, from Whitney's Metallic Wealth of the United States.

In the latter work, the amount deposited from 1838 to 1847, inclusive, is given, in the aggregate, at $50,446; while in the former, the amount for the same time is but $16,499, making a difference of $33,947. As the product of each year is specified in Dana's Manual, we adopt $16,499 as being most likely correct. Whitney gives $79,970 as the entire yield for the period included in the table above.

VALUE OF TENNESSEE GOLD DEPOSITED AT THE UNITED STATES MINT, ETC.

Years.	Value.	Years.	Value.	Years.	Value.
1831	$1,000	1839	$300	1847	$2,511
1832	1,000	1840	104	1848	7,161
1833	7,000	1841	1,212	1849	5,180
1834	8,000	1842		1850	1,507
1835	100	1843	2,788	1851	2,377
1836	300	1844	2,240	1852	750
1837		1845	3,202	1853	149
1838	1,500	1846	2,642		
					$46,023

The largest *piece* of native gold that we have heard of, found at any time in the Coco region, weighed twenty-one pennyweights; a smaller piece weighed eleven.*

141. *Source of the Gold—the Whippowil Vein, etc.*—There can be no doubt that much of, and, it may be, all the gold found in Tennessee has been derived from *quartz veins.* Liberated by the disintegration or crumbling of these, the rains and the streams have washed it, together with gravel, sand, etc., into their beds and other low places. Within a few years, this view has been confirmed by the discovery of a *gold-bearing quartz vein* in the Coco Creek region. This has been found on a small branch called *Whippowil,* the waters of which find their way into the Tellico. The place is near a low ridge, dividing the Coco Creek and Tellico waters, and is about six miles eastward from the Tellico iron-works.

142. Through the kindness of Austin Fry, Esq., an intelligent gentleman living in the vicinity, we have had an opportunity of seeing and examining this interesting locality.

The vein is of the *segregated* class,† and lies in *between* the strata, not intersecting, but dipping with them to the south-east at an angle of about forty-five degrees. It is composed of brittle quartz,

* A pennyweight of American native gold is usually worth from ninety-five cents to one dollar.

† See note on page 64.

rather compact, but occasionally affording cavities, some of which are rhombohedral in outline, and filled with brownish or yellowish ferruginous matter from a decomposing mineral. This vein or sheet of quartz has an average thickness of about six inches; its surfaces have a wavy or rolling character like those of the adjoining slates.

The outcrop has been exposed for many yards running up the side of the hill. The gold occurs in grains and scales through the quartz, and also occasionally in the ferruginous matter mentioned above. We saw many fragments of quartz, taken from the vein along its outcrop, containing visible particles. Some very fair cabinet specimens have been obtained.

143. A company has been formed, under the style of the Whippowil Mining Company, who propose to ascertain the richness of the quartz, and the extent of the vein.

The Whippowil vein we regard as but one of many auriferous veins like it, some of them perhaps much more extensive, which may be found at different points in the region specified in the beginning of this section.

144. *Geological Relations.*—The rocks of the Coco Creek and Whippowil district are *talcose* and fine *semi-micaceous* slates of pale bluish and greenish colors, sometimes with a silvery lustre. Segregated veins of quartz are very numerous. This we judge to be the character of the rocks all through the shallow depression of which we have spoken. (§ 138.)

A few miles farther south-east, the *conglomerate* becomes abundant, and the country rises up in the great ridges along the line. In the opposite direction, going towards Tellico iron-works, the slates alone are found for a few miles, when the conglomerate again, and sandstones, begin to appear, and the country becomes rougher and higher. Very soon after passing the iron-works, the mountains are left behind, and the valley formations commence.

SECTION V.

SILVER.

145. *Silver in the Cumberland Mountain.*—Though no veins or deposits of silver ore are *known* in Tennessee, yet we believe that such do exist. There are some facts, perfectly reliable, connected with this subject, which are interesting, and ought to be known. Several fragments of the *sulphuret of silver*, from two distinct localities, have been found.

146. In regard to those first found, Major Eastland, who lives on the Cumberland Mountain, in White, on an air-line perhaps about ten miles east of Sparta, and on a small tributary of Caney Fork, called Clifty, has furnished us with the following particulars:—

Nearly twenty years ago, a person, whose name was forgotten, brought to Major E. some fragments of an unknown mineral, which he desired to have examined, remarking, at the same time, "There is plenty more where it came from." Major Eastland, not knowing what it was, laid it aside. A year or two afterwards, Dr. Troost, returning home that way from one of his excursions, and to whom the fragments were handed, took them with him to Nashville. Upon examination, he found them to be sulphuret of silver, and immediately wrote to Eastland, informing him of the fact.

147. It was soon ascertained that the person who had discovered the ore had, in the mean time, moved to Arkansas. A letter, written to him, however, was answered by another, giving information of his recent decease. By this unexpected news—just as the "evanescent treasure," romance-like, was about to be secured!—the direct clew to the locality was lost.

It is known, however, that the specimens were obtained somewhere between Eastland's and Pikeville, on the south side of the Caney Fork.

We mention these facts in order that those who live between the points specified may be apprised of the circumstances, and may pay some attention to the minerals occurring around them; perhaps

thereby the locality may be rediscovered. If found, the ore will be most likely associated with lead, in some vein or deposit in the great limestone formation, which constitutes the base of the Cumberland.

148. In addition to the ore spoken of above, another specimen of the sulphuret of silver was discovered by Dr. Troost. This, no doubt, was originally derived from a locality entirely distinct from the other. It was discovered by the Doctor after leaving Major Eastland's, where he had, the evening before, received the first specimens. He says:* "Next morning I left that place, and passing through Sparta, I descended to the Calfkiller Creek, to water my horse; my attention was there attracted by something uncommon amongst the gravel; I dismounted, and took up the substance which had drawn my attention." When he reached home, the mass, together with those obtained from Major Eastland, was examined, and found to be sulphuret of silver; the latter "containing also sulphuret of lead;" that from the Calfkiller being "pure sulphuret of silver, covering and penetrating crystallized fluate of lime."

149. In regard to the *source* of this sulphuret, the Doctor says: "This limestone"—that of the banks of the Calfkiller—"is covered here and there by the sandstone of the coal formation, and no vein of silver, or fluate of lime, can be expected to be found in it. It is the same with the oölitic limestone, which is the highest stratum of our mountain limestone series, in which I never found any metallic vein or other mineral substance; it must, therefore, belong to some older rocks."

We think differently, and believe that all these fragments have been derived from the Carboniferous or Mountain Limestone. We *know* that both fluate of lime and sulphuret of lead do occur in it, and can see no reason why the sulphuret of silver should not.

We have seen that the Sparta specimen was found in the bed of the Calfkiller. This stream originates twenty miles north-east of Sparta, on the Table-land, but soon descending, flows south-westward, not far

* Fifth Report, 1889.

from the slopes of the mountain, and over the Carboniferous Limestone rocks. It is altogether probable that this specimen came from some vein or deposit, either on the limestone slopes of the mountain, or at some point along the banks of the Calfkiller.

The Eastland fragments most likely came from some of the deep valleys or gulfs formed in the Table-land by the tributaries of the Caney Fork.

150. The *Sulphuret of Silver*, called also *Silver Glance*, and *Vitreous Silver*, consists, when pure, of

Silver	87·04
Sulphur	12·96
	100 00

This is a common ore in the Mexican mines, as well as in the mines of South America. It is the most important ore of this metal.

151. *Silver in Lead—Indian Stories.*—Some silver, though generally in mere traces, is found in our lead ores. We know, as yet, of no locality of any importance, though such may be looked for. A lead ore containing five or six per cent. of silver may be regarded as a silver ore.

The *numerous* old Indian stories about silver mines, which are so common in East and Middle Tennessee, there being at least one, perhaps two, on an average, for every county, are entitled to little or no credit. To give a specific account of them would require a volume, which, when written, would be worth practically nothing.

SECTION VI.

ALUMINUM, OR THE METAL OF CLAY.

152. *The "New Metal," and its Properties.*—In order to show what chemistry is doing for the useful arts, and to show, in addition, what a valuable *metallic* product the very *clay* we daily so thoughtlessly tread upon may be made to afford, we desire to notice the metal *aluminum*, which has recently attracted so much attention.

153. It may appear strange to many, yet without doubt *clay* is as truly an ore of a metal as any of the ores of iron, copper, silver, etc. Within the last two years, this metal—called *aluminum*,* from *alumina*, the chemical name of pure clay—has been obtained under circumstances which promise much for its future usefulness.

Through the kindness of Col. Samuel D. Morgan, of Nashville, who, in addition to having done much for the geology of Tennessee, has always taken an active interest in the progress of general science, we have had the pleasure of seeing a small bar of this metal, procured from Paris, where it is at present manufactured.

154. As now prepared, it is nearly as white as silver: it can be beaten into thin plates, and drawn out into wire. It has about the melting point of silver.

The density of aluminum is 2·56; or, in other words, it is but little more than two and a half times heavier than water, while it is about four times *lighter* than silver, seven and a half times lighter than gold, and nearly eight and a half times lighter than the heaviest of metals, platinum. "Its hardness is increased by hammering, but it again becomes soft on heating. It is a good conductor of heat, and can be fused and poured out in the air without becoming sensibly oxydized."† Water, strong and weak nitric acid, and dilute sulphuric acid, have no action upon it; muriatic acid dissolves it.

It appears to be remarkable, too, for its sonorousness, comparing with the best bronze in this respect, and "having a quality of tone not hitherto observed in any metal in the pure state." It is highly electro-negative, and promises to be of great service as an element in galvanic batteries.

155. These properties are sufficient to make this curious metal very useful. It has already been applied to several purposes in the arts, and will, no doubt, be much more extensively applied, if chemists succeed in reducing sufficiently the cost of its production, which they

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* A-lu′mi-num, or al-u-min′i-um.

† American Journal of Science, vol. xvii., etc.

appear to be in a fair way to do. Its manufacture "is encouraged by the French government, who wish to procure a large quantity of this metal, in order to use it for cuirasses, (breast-plates,) and other purposes, for which it is especially fitted by its tenacity and lightness."

It is also proposed to use it in the construction of delicate balances. "Hard aluminum acquires, by annealing, an inflexibility, which," together with its lightness, "would make it of great use in the suspension of all kinds of scales for assays or analyses." It is stated to have been employed in making watch-wheels, and to answer the purpose well.

When properly alloyed with iron, it forms a very hard steel, which has received high commendation from many French manufacturers. It appears also to have the property of preventing the rusting of iron, when combined with it in certain proportions.

156. *The History and Cost of its Production.*—Although called a "new metal," it is not so strictly; it is only its solid compact form that is new. Aluminum has been long known in a state of fine gray metallic powder, and, as such, is described in all chemical works, unless published very recently. In this condition it is of no practical importance. To M. Sainte Claire Deville, a French chemist, belongs the honor of producing it in its present useful form.

157. To obtain this metal, *alumina* (chemically pure clay) is first prepared from a certain kind of alum, of which, as well as of all alums, it is a constituent.*

This alumina—which is, by the way, an oxyd of the metal—is then converted, by the action of *chlorine*,† into a compound of chlorine and aluminum, or, in other words, into the *chlorid of aluminum.*

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* Common clay, even the purest varieties, such as potter's and pipe clay, contain too much foreign matter, etc., to be used directly. These consist of alumina one-third part only, the rest being sandy matter, (silica.) They can be used, however, in the manufacture of alum.

The plasticity of clays is due entirely to the alumina they contain.

Ten pounds of pipe clay has about one pound and three-quarters of the metal aluminum in its composition.

† A heavy yellowish-green gas. It is an elementary body; has a very suffocating smell; acts with energy upon many substances, and is best known as the efficient constituent in bleaching-powder, such as "chlorid of lime," etc.

The next step is to decompose this compound, which is done by means of another metal—*sodium*—long known to chemists, and entering into the composition of common soda and salt. Sodium, coming in contact with the chlorid at a high heat, decomposes it, and liberates the aluminum, which is then collected.

158. The use of sodium has heretofore rendered the process very expensive. It has been the constant aim of M. Deville to reduce the cost of preparing this metal; in this he has succeeded beyond all expectation. When the experiments were commenced, about two years ago, the cost of sodium was not far from eighty-five dollars per pound avoirdupois, which alone would make the price of aluminum two hundred and fifty-five dollars per pound. Now, however, the price of the former metal, when sold in the large way, has been reduced to about eighty-five cents per pound, and the cost of all the materials necessary to the production of a pound of aluminum to two dollars and seventy cents. This is a very great reduction. An important object has been gained in the reduction of the price of sodium alone, without any reference to aluminum. The price is now low enough to admit of its being used for many useful purposes in the arts and in common life.

159. What the cost of extracting aluminum may be, in addition to the cost of the materials, we are not informed. For the sake of comparing its value with that of silver, we may suppose the entire expense, including materials, to be four dollars per pound. American standard silver is worth sixteen dollars and eighty-four cents per pound avoirdupois. At these rates, the cost of aluminum, when sold in the large way by the pound, would be about one-fourth that of silver.

Owing, however, to the difference in weight, a pound of aluminum will have four times the volume of an equal weight of silver; when, therefore, equal bulks are compared, the cost of the former metal is but one-sixteenth that of the latter.

It is not improbable that the cost of producing aluminum will be still further diminished, and that this metal will become of world-wide importance. If so, we have no lack of *ore* in Tennessee for the production of our share!

CHAPTER IV.

THE MINERAL WEALTH OF TENNESSEE, CONTINUED.—GEOLOGICAL PRODUCTS NOT USED AS ORES, ETC.

In addition to the ores and metals, which constitute by themselves a distinct division, we have another class of mineral resources, of great interest and value. To these—our *coal*, *marble*, *green-sand*, *cement-making limestones*, *buhrstones*, *etc.*, *etc.*—the present chapter is devoted. We give, however, not much more than outlines, to be filled up hereafter.

SECTION I.

STONE COAL.

160. In our reconnoissance, we have crossed and explored, more or less, the extensive table-land in which our *coal* occurs, along six different routes, besides making numerous excursions along its escarpments on both sides. Opportunities have been afforded of examining many banks throughout its whole extent. Many sections have been completed, and others are in progress. We hope soon to be able to give a digested and full account of this great *State treasure*, for it is nothing less, and ought to be so regarded.

The future prosperity of Tennessee is more intimately connected with her coal fields than she is aware of. Iron ore and stone coal are before all other minerals put together in furnishing elements of national wealth and power. Every part of the State, from Shelby to Johnson, is interested, and has much to gain from a systematic eluci-

dation of what is contained in our coal measures. A thorough development will give a definiteness to the extent, quality, and location of our coals, greatly needed, and will add a new stimulus to mining operations. It is altogether probable that within twenty or thirty years, or perhaps in much less time, Tennessee coal will be used in every county in the State.

161. *Extent and Quantity.*—Although we have not worked out all the details in regard to our coal, yet we have data sufficient to enable us to form a satisfactory idea of its extent and quantity.

A general description of the Cumberland Table-land has been given. (See §§ 26–30.) We have computed its area from the best data we could get, and believe it to be *four thousand four hundred square miles.* Its position and extent are correctly given upon the map. Coëxtensive with it, *stone coal,* in strata thick enough, and of a quality good enough to be profitably mined, is found.

162. Commencing in the southern part of the State, the coal measures, consisting of the sandstones, coal, and shales, which, resting upon limestone, cap the mountain or Table-land, are not as heavy as they are farther to the north-east, yet they afford much coal. At least *three* distinct and usually horizontal strata can generally be detected on the slopes of the mountain; at some points *four* and even *six* can be pointed out.

163. In the *narrow valley* which the Tennessee has cut out through Walden's Ridge, we have seen on the north side of the river as many as *four* horizontal coal-seams, cropping out successively below the crest of the mountain.* One that is worked is from two to three feet thick; the others, not having been penetrated, at least at the point examined, were only exhibited along their thin outcrops. When properly tested, they may prove to be of profitable thickness. At this point, so far as

* The bluff slopes of this southern fragmentary portion of the Table-land, including always Walden's Ridge, Raccoon and the mountains west of Sequatchee valley, are terminated above, as seen from the valleys, by a hard sandstone *crest.* Back of this, at a greater or less distance, a comparatively level space intervening, are slopes of ridges—*summit* ridges—and great flat areas, which may be regarded as resting upon the general table. Beds of coal occur, both in these and below the crest.

we know, no coal has been obtained from the summit ridges, though in all probability valuable beds exist. On the opposite side of the river, in corresponding rocks, and at a similar elevation, excellent coal-seams are known.

164. Near the Nashville and Chattanooga Railroad, in *Raccoon Mountain*, there are several banks which have been extensively worked. Owing to want of time, we have not had an opportunity of visiting this interesting region.* Reliable information, however, has been obtained from gentlemen well acquainted with the resources of these mountains. We are especially under obligations to Col. J. A. Whiteside, of Chattanooga, who has furnished us with a list of the coal-seams known by him to occur in Raccoon Mountain. Commencing with the lowest and ascending, they are as follows:

6th. Coal five and a half feet, including a band of slate;

5th. Coal four feet—Walker's bank;

4th. Coal three feet—Kelly's bank;

Crest or *Bench* of the mountain;

3d. Coal fifteen inches?

2d. Coal twenty-four inches?

1st. Coal twenty-four to forty-inches—Vaughn's bank.

It will be seen that three of these are below the crest of the mountain; they are doubtless continuous with corresponding ones exposed along the Tennessee River. The others occur in the *summit* ridge or table back from the main slope. The aggregate thickness, excluding the slate in the upper seam, is about seventeen feet.†

165. On the *Cumberland, west of Sequatchee Valley*, coal-seams again occur under circumstances similar to those we have mentioned, being found both below and above the crest of the mountain. These are to be regarded as extensions originally of those in Raccoon. We shall refer briefly to but one of them.

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* It will be, in part, the work of another season to make out complete sections of all the rocks, including the coal, of this portion of the Table-land.

† The entire thickness of the coal measures in Raccoon Mountain cannot be much if any less than one thousand feet; it may exceed this.

In the summit ridges, along the line of Marion and Grundy, there is an excellent stratum, from five to six feet thick, and furnishing superior coal. The *Wooten* bank is in this. Most of the property in which it occurs belongs now to the Sewanee Mining Company. (§ 177.)

166. Passing to the *central and western part* of the Table-land, that portion, for example, in White county, we find several coal-strata well developed. We know here of at least three distinct and continuous layers, two of which are important. One affords four or five feet of excellent coal; the other, from which Sparta is supplied, is the lowest, and will, perhaps, average four feet. This stratum, associated with shale, lies below the the sandstones, and not far above the limestone. It may be coëxtensive with the Table-land in this position. We have seen it in Grundy, many miles southward, and in Overton, as many northward. In thickness, it varies from two feet to four and a half. It is thickest in White, and in the counties farther north.

167. The facts in regard to the coal of Putnam, Overton, and Fentress are about the same as those stated with reference to White.

168. The coal measures of the *north-eastern part* of the Table-land, in Morgan, Anderson, Scott, Campbell, etc., swell out to a very great thickness—at some points to more than two thousand feet. (See § 27.)

On the mountain around Montgomery, there are several beautiful exposures of coal, and at least three strata known.

In the vicinity of the salt-works, in Anderson, an extensive section is afforded, containing not far from a *dozen* seams of coal, which vary from a few inches to at least seven feet, with an aggregate thickness of not less than twenty-five feet. The banks in Anderson, from which Knoxville is in part supplied, are in nearly a horizontal stratum, six and seven feet thick, and furnish coal of excellent quality.

169. At many points along the *eastern escarpment* of the mountain, in Roane, Rhea, and Hamilton, there are several coal-seams and superior banks, from four to six feet in thickness.

170. Finally, after reviewing the whole field, we have no hesitation

in saying that our coal, of good quality and in beds thick enough to be profitably worked, is *at least* equal, in the aggregate, to a solid stratum, eight feet thick, and coëxtensive with the Table-land, and hence equal in extent to four thousand four hundred square miles; or, in other words, equal in volume to *a solid block of coal eight feet high, twenty miles wide, and two hundred and twenty miles long.* This, for the present, we give as a *safe estimate,* though we believe the quantity to be greater.

171. *Quality of Tennessee Coal.*—We necessarily defer a systematic account of the quality and varieties of our coals. There is no question, however, as to their excellence and value. There are, it is true, some, as in all coal-fields, which are of indifferent quality, but, in the aggregate, we believe they are not, for general purposes, surpassed.

The varieties are numerous. Most of them perhaps are semi-bituminous, dry burning coals, but others are properly bituminous.

172. In structure, too, they differ. Along the eastern edge of the Table-land, where the rocks have been subjected to disturbances, the included coals have often a *spumose** structure, breaking up in small angular fragments, with concave and convex faces. In the horizontal rocks, which, by the way, make up the great body of the Table-land, they are generally laminar, even, and more or less compact. Sometimes, however, even in this case, they exhibit irregularities.

Hereafter we will aim to present a complete table of the composition and peculiarities of the coals from all our principal banks, adding also the uses to which they are best adapted.

173. The following analyses, with the exception of No. 4, were made by Dr. Troost.† No. 4—kindly furnished us by Mr. S. F. Tracy, the energetic President of the Sewanee Mining Company—is an analysis of the Wooten coal, (§ 165,) made by F. Zwickl, of New York.

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* Or, spumous.

† Nos. 1 and 2 are given in his Third Report, and No. 3—said, indefinitely, "to have come from near the Tennessee River"—in his Ninth.

ANALYSES OF TENNESSEE COALS.

No.	County.	Name of bank.	Specific gravity.	ANALYSES. Carbon.	Volatile matter.	Ashes.
1	Roane..........	Kimbrough's...	1·45	71·00	17·00	12·00
2	Rhea............	Gillenwater's..	"	69 00	14.00	17·00
3	?		....	76·00	17.00	7·00
4	Marion	Wooten's.......	....	65·50	29.00	5·50

174. *Production, etc., in* 1854.—The following table will indicate the amount of coal produced in 1854, and how and where it was consumed. Remarks are also occasionally included, with reference to the price at which sold, the character of the banks, etc., etc.

PRODUCTION AND CONSUMPTION OF TENNESSEE COAL IN 1854.

COUNTY.	BUSHELS RAISED.	REMARKS.
CLAIBORNE	500	Used by blacksmiths mostly. Two thousand bushels in addition were brought from Kentucky.
CAMPBELL..................	4000	Consumed by blacksmiths mostly. Fine banks occur, from four to six feet thick.
ANDERSON.		
(*a*) Coal Creek..........	3000	Used by blacksmiths mostly.
(*b*) Poplar Creek.......	35,000	Coal consumed for manufacturing and domestic purposes, in Knoxville, North Alabama, and by blacksmiths of the county. Excellent banks, six and seven feet thick. Fifty thousand bushels estimated production of 1855. Coal in Knoxville is worth from 18 to 25 cents per bushel.
ROANE.		
Kimbrough's bank...	83,000*	One third made into coke, and sent to Knoxville, Georgia, and Alabama. Sold near the bank at 15 and 12½ cents per 40 lbs. The remainder consumed in Loudon and Knoxville for manufacturing and domestic purposes. Sold near the bank at 12½ and 10 cents per each 70 lbs.

* A larger amount was given us, but estimated at seventy pounds to the bushel.

COUNTY.	BUSHELS RAISED.	REMARKS.
RHEA. Roddy's bank.*.......	2000	Used in the vicinity. In 1853, about 20,000 bushels were raised at this bank, and consumed at Eagle Furnace, Chattanooga, and in Georgia, for purposes as above.
HAMILTON & MARION. (*a*) Jack's bank.........	1000	In 1853, raised 15,500 bushels. Sold at 7 cents at the bank.
(*b*) Clift and McCree's.	25,000?	Perhaps more.
(*c*) Tennessee River...	14,000	Two or three banks where the river breaks through Walden's ridge. Coal delivered on the bank at about 10 cents, and consumed mostly in North Alabama.
(*d*) Raccoon Mountain.	24,500	Banks near the railroad, (See § 164.) Coal sent to Nashville, Chattanooga, and Georgia. Consumed as above. Estimated production of 1855, 300,000 bushels.†
(*e*) Battle Creek.........	11,000	Two or three banks.
FRANKLIN..................	15,000?	Used mostly in Winchester for domestic purposes, and by blacksmiths, etc.
GRUNDY................. WARREN................. VAN BUREN............	8500	Used in the counties mostly by blacksmiths. Coal delivered in McMinnville costs about 20 cents. There are numerous banks in these counties of various thicknesses: many of them from three to four feet—some thicker.
WHITE......................	15,000	Used within the county, mostly in Sparta, both by blacksmiths and for domestic purposes. In great part obtained from two banks, from three and a half to four and a half feet thick. (See § 166.)
PUTNAM................. OVERTON .... FENTRESS................	1400	Used by blacksmiths. Considerable coal was sent, a few years ago, from Fentress to the Nashville market.
SCOTT.................... MORGAN................. BLEDSOE	4500	Used by blacksmiths mostly. Numerous exposures of coal, from one to six feet, many of them of excellent quality.

* Or, Gillenwater's. (See table, § 173.)

† Not having the exact amount, we have estimated the production of these banks, in 1855, at 9000 tons. (See § 176.)

As far as possible, these statistics have been derived from the *proprietors* of the banks themselves. In all other cases, gentlemen acquainted with the coal and coal-trade of their respective counties, have been consulted, and have furnished us with the necessary local facts and estimates.

The entire amount is 247,400 bushels, or 8836 tons.*

175. *Production of* 1855.—There has been, this year, a great increase in the production of Tennessee coal; due,

First, to the greater activity of operations at the Raccoon banks, and at other banks in East Tennessee, but mainly the former; and,

Secondly, to the commencement of coal-mining by the Sewanee Company.

176. In reference, first, to *the Raccoon banks*, we were informed, in June last, that they would produce during the year (1855) 300,000 bushels, or something more than 10,714 tons. From the best information we have, the yield appears, so far, to have come up to the estimates. Not having, however, positive statistics, we place the amount at 9000 tons, which is an increase of 8125 tons over their production in 1854.†

177. The *Sewanee Mining Company* was organized in January, 1854. They soon secured valuable coal-lands on the western side and on the summit of the Cumberland, in Franklin and adjoining counties, and have *already* a railroad nine miles in length, connecting their nearest banks with the Nashville and Chattanooga road at the tunnel. The coal of the Table-land is thus directly connected with the capital of the State. It is the intention of the company to extend their road eleven miles farther, to the "Wooten" bank, (§ 165,) where there is an inexhaustible supply of superior coal.

The first car-loads of Sewanee coal were sent to Nashville *in June*

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* In Tennessee, a bushel of coal is fixed by law at eighty pounds, which is twenty-eight bushels to the ton.

† At the close of this year, these banks go into the hands of the "Ætna Mining and Manufacturing Company." This company has a *working* capital of $40,000, and will doubtless prosecute coal-mining in the Raccoon ranges with still greater activity.

last. Up to the last of December, (1855,) 3823 tons had been delivered at the city dépôt.

178. The production of 1855 will, therefore, stand in tons as follows:—

Increase over last year at Racooon banks	8125
Sewanee banks	3823
Production of last year	8836
Total production of 1855	20,784

In this we allow nothing for the increased quantity of coal raised at other banks, which would swell the total amount to 21,000 or 22,000 tons.

In 1856, the amount of production may again be more than doubled.

179. *Consumption of Ohio River and Kentucky Coal in Tennessee.*—A large amount comparatively of Kentucky coal is consumed in Tennessee. It is brought into the State from *four* distinct regions. We will enumerate these, in connection with the amount that each furnished in 1854.

In the first place, about 2000 bushels were carried, last year, from the south-eastern corner of Kentucky, through Cumberland Gap, into Claiborne county.

Again, as nearly as we can ascertain, about 600,000 bushels, or 21,428 tons, were brought down the Cumberland River in 1854, from that part of the Cumberland coal-field in Kentucky cut by this river. Of this amount, about 400,000 bushels were consumed in Nashville, 140,000 by the Cumberland Rolling-Mill, in Stewart, and about 60,000 at Clarksville, etc.

In the third place, coal, to a limited extent, and mostly for the use of blacksmiths, has been occasionally, for several years, brought from Kentucky to Clarksville, from the part of the "*Illinois*" coal-field which lies in Christian or in the southern part of Hopkins county.

Lastly, considerable coal, in 1854—how much we do not know, perhaps 75,000 bushels—was brought from the Bell mines, near the Ohio River, in Kentucky.

180. Recently, some of the highly bituminous Pittsburgh coal has

been brought to the Nashville market. It is now used at the Gas-Works, and is found to yield a cubic foot more gas to the pound than up-river Kentucky coal. It is not, however, valued more for ordinary purposes than the good Tennessee and Kentucky semi-bituminous coals brought to the city.

181. Hitherto the maximum consumption per annum of coal in *Nashville* has been about 450,000 bushels, or 16,071 tons. The supply, however, within three or four years past, has not been equal to the demand. With an abundance of coal at twelve or thirteen cents per bushel, the consumption would soon be doubled. At present, the price varies from fifteen to twenty-five cents, occasionally reaching forty cents. From eighteen to twenty cents is perhaps a fair average for the year.

Memphis is supplied with coal mostly from Pennsylvania. Her annual consumption "is about 120,000 barrels,"* or 300,000 bushels.

Clarksville—one of the most important commercial points in the State—uses perhaps about 125,000 bushels,† which is obtained from Kentucky, both from up and down the river. Some Pittsburgh coal is also doubtless used at this point.

SECTION II.

LIGNITE.

182. Lignite is an imperfect variety of mineral coal.‡ It is generally brown, or brownish-black, and often presents a *woody* structure, being, in fact, an incipient stone coal, occupying an intermediate place between it and dead vegetable matter. It is not unusual to find, running through beds of lignite, half-carbonized leaves, sticks, and fragments of the branches and trunks of trees. Its odor and fumes

* Furnished us by L. R. Richards, City Register.

† We have been expecting to receive the actual amount, but it has failed to reach us in time.

‡ See Prof. J. D. Dana's excellent "Manual of Mineralogy," sixth edition, p. 86.

in burning are not altogether like those of true coal, but resemble more the pungent, eye-irritating odor and fumes of burning, half-smothered wood.

183. Geologically, it is of modern origin; the formations in which it occurs being above or more recent than that which is, in the main, the great depository of our true stone coal.

184. There are vast quantities of lignite in the Mississippi and Missouri valleys, and it becomes speculators in mineral fuel to keep a lookout, lest they mistake this half-formed coal for the valuable and substantial coal of the Carboniferous Formation. Already, within our own State, *expensive* mistakes have been made.

185. Its *value* is mostly prospective. When the forests of the Mississippi bottoms can no longer furnish wood—when our great coal fields shall have yielded their treasures, then the lignite beds will be looked to. But, on the other hand, when will this be? Our coal resources are considered to be inexhaustible, and the only answer returned is that of the daughter of Air and Tellus—When?

In some countries, where fuel is scarce and expensive, lignite has been used. The better qualities, when mined and ready for market, are for some purposes equal to wood in value. The mining of it, how ever, in the Valley of the Mississippi will be attended with difficulties, on account of the unconsolidated nature of the strata which enclose it.

186. *Occurrence of Lignite in Tennessee.*—Along the Mississippi Bluff, extensive beds occur in Lauderdale, Tipton, and the northern part of Shelby. The following section, taken at "Old River," in the southern part of Tipton, will exhibit the different strata, which at that point compose the Bluff, and the mode in which the included beds of lignite occur.*

* We are under especial obligations to Dr. C. W. Dickson, of Portersville, for kindly guiding us to this point—a distance of sixteen miles from his residence—and for aiding us in our investigations.

We take this occasion, too, to express our sincere thanks to Dr. Oldham, of Ripley, who, notwithstanding his engagements at home, travelled with us to and from the lignite localities near Fulton, a distance of fifty miles in all.

From both of these gentlemen we received much valuable information in regard to the geology of their respective counties.

SECTION OF THE MISSISSIPPI BLUFF AT "OLD RIVER."

(*Entire thickness about* 168 *feet.*)

GENERAL DIVISIONS.	THICKNESS IN FEET.	THE STRATA, ETC.
LOAM BEDS......	45	*Top of Bluff.* (*a*) Bed of light-yellow ashen earth or loam, more or less calcareous; contains land-shells, (*helix*, *cyclostoma*, etc.) The lower part becomes more yellow and sandy.
GRAVEL SERIES.	39	(*b*) Layers of orange and yellow sand, with thin seams of red sandstone—three and a half feet. (*c*) Bed of coarse *gravel* and sand—sixteen feet. (*d*) Reddish and white potter's clay, in seams with sand—one foot and a half. (*e*) Bright yellow sand, with occasional seams of clay—eighteen feet.
LIGNITE SERIES.	84	(*f*) Thin seams of gray or white sand and clay, interstratified with some vegetable matter—fifteen feet. (*g*) Bed of *lignite*, from three to four feet. (*h*) Dark clay and *lignite* interstratified—two feet. (*i*) Seams of gray and white sand, interstratified with layers of lignite—five and a half feet. (*j*) Bed of *lignite*, six inches—becoming, a few hundred yards to the left, along the Bluff, four feet thick. (*k*) Gray sand in thin layers, with numerous seams of dark clay and layers of *lignite*, some of which are from three to six inches thick—thirty-two feet. (*l*) Same as above mostly; one bed of *lignite*, (leaves, etc.,) two feet thick—fifteen feet. (*m*) Beds of dark laminated clay. The base of the Bluff is concealed mostly by a talus of materials from above—ten feet? *Level of alluvial plain.*

187. Similarly interstratified with sand and clay, lignite occurs at numerous localities along the Bluff, from the Forked Deer to Shelby. Occasionally the beds are five and six feet in thickness.

At Raleigh, a bed of lignite crops out at the base of the Bluff, on Wolf River. The section here is similar to that already given, though not running down as far. We were informed that lignite from this stratum had been used with wood for several weeks at a steam saw-mill in the vicinity, with tolerable success.*

188. In *Carter county* it occurs with clay, in an isolated and curious deposit or patch, a few miles north of Elizabethton, at the termination of the mountain which separates Carter and Sullivan. Its lateral extent appears to be limited. A pit has been sunk through the clay into the lignite, penetrating the latter, as we were informed, nine feet. At the time of our visit, the excavations were partly filled with water, which prevented as thorough an examination as we desired.

SECTION III.

MARBLE.

189. There is great interest and importance attached to the marble of Tennessee. It is now—in the columns and balustrades which within adorn the building—one of the chief ornaments of our own noble capitol, as it will be soon of the national capitol at Washington.

Our examinations, as far as possible, have also been extended to this product of our rocks, and with gratifying results. We have had the pleasure of pointing out valuable beds, not hitherto noticed, both in East and West Tennessee.

* In most of the counties in West Tennessee, half-carbonized wood, sticks, leaves, etc., have been met with in digging wells. Sometimes a large trunk is encountered, much to the annoyance of the well-digger.

190. The principal species* of marble in the State are the following:—

1st. *Variegated Fossiliferous;*

2d. *Grayish White Fossiliferous;*

3d. *Magnesian;*

4th. *Black;* and the

5th. *Breccia and Conglomerate Varieties.*

1st. *Variegated Fossiliferous Marble.*

191. *Where Found.*—This, the most important species, occurs in West, Middle, and East Tennessee, but is most abundant and of the finest quality in the last mentioned division of the State.

In West Tennessee there are beds of good quality, which are rendered highly valuable, from the circumstance of their affording almost the last limestone seen in going west to the Mississippi. In Henry there is a quarry from which considerable marble, for building purposes and for tombstones, has been taken. Some of it has been carried to Paris, more than twelve miles distant, and used in the construction of the foundation of the court-house, and for other purposes.

In Benton, as, for instance, a few miles from Rockport, on the Tennessee, the present residence of our Senator from Benton, etc., Mr. A. P. Hall, the same rock occurs. It is also seen farther south, in Decatur, etc.

192. In Middle Tennessee, in Franklin county, there are many localities of marble, and several extensive beds. It has been worked here, to a limited extent, for several years.

The upper part of the Mountain Limestone at Bon Air, in White, affords a clouded marble, from which a few tombstones have been taken.

193. In East Tennessee the localities are very numerous. Commencing with the northern part of the valley, we meet with it in

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* This term is not used here in its strict scientific sense, but simply in a general way, to designate the different divisions enumerated.

nearly all the counties west of Greene and Sullivan. In Hawkins, running along a few miles west of Rogersville, there is a most valuable bed, in which several quarries have been opened. We will have occasion to refer to these again.

In Grainger, Jefferson, Knox, Roane, Monroe, Meigs, McMinn, and Bradley, it occurs more or less abundantly. In the vicinity of Knoxville, as in Hawkins, there are several extensive quarries; of these, too, we will speak again.

194. *Its Character and Quantity.*—In East Tennessee there are two distinct varieties of this marble. One is an argillaceous limestone, little fossiliferous, of dull, gray, brownish-red, and sometimes greenish colors, arranged in undefined banded clouds. It receives a smooth, good polish. Such marble has been quarried and worked to some extent in Roane, Meigs, etc. It was used in the construction of the foundation of the court-house in Kingston.

195. The most important variety, however, and a superior marble, is that which is seen in the quarries of McMinn, Knox, and Hawkins.

This, which may be called *par excellence* the marble of East Tennessee, is a highly *fossiliferous* and calcareous rock. It has, in its polished condition, a bright ground of brownish red colors, which are more or less freely mottled with white and gray fleecy clouds and spots. In that of the first quality, these clouds and spots are distinct and well defined, showing, at the same time, little of their fossiliferous nature. The brownish-red color of the ground varies, having at some points a darker shade than at others. We prefer the lighter ground. Other secondary qualities, though often beautiful marbles, have not as well-defined clouds, etc., and their fossiliferous portions show too distinctly their organic structure. Some, however, might prefer to see the latter character.

196. The marbles of Middle and West Tennessee are of the same nature, and resemble more or less those of the Eastern Division.

197. As to the *quantity*, it is sufficient to say that we have enough to supply the world, and that, too, of the best quality. The great bands of marble, often many hundred feet in width, which run through

East Tennessee, can never be exhausted; at least, we cannot conceive of how and when it could be done. The most important of these are cut by navigable rivers, and many of them already by railroads, rendering practicable the opening of extensive quarries at hundreds of convenient and accessible points.

We defer, for the present, an enumeration of the different marble ranges; some have already been wholly made out, and many partially. As soon as our materials are complete, we will present as full an account of them as their importance demands.

198. *Geological Character and Relations.*—We have called this a *fossiliferous* rock, meaning thereby that it is composed, in good part, of *petrified* or *fossil* corals, shells, etc. The corals, together with the remains of a class of animals called *crinoids*, are most abundant. To the presence of these the variegated variety owes, for the most part, its peculiar character and beauty.

199. In East Tennessee this marble forms one of the lower members of Formation V., hereafter noticed. It is usually *heavy-bedded*, and admits of the splitting out of very large and massive blocks. As a general thing, the strata which compose it dip with the associated rocks, at an average angle of nearly forty-five degrees to the southeast.

200. In Middle and West Tennessee, the marble beds are horizontal. In Franklin, they occupy a position in the upper part of Formation V. In the District, they are of a very different geological age, constitute a member of Formation VI., and are not as heavy as those in East Tennessee.

201. *Production of Variegated Marble in East Tennessee.*—The systematic production of marble appears to have been first commenced in Hawkins.

The principal marble in this county occurs in a band about twelve miles in length, which runs south-westward through a portion of the valley west of that in which Rogersville is located. Several quarries, at distinct and distant points, have been opened, which furnish a product of the first quality.

The history of the production here is as follows:—In the first place, we have been assured that attention, resulting in any thing practical, was called to the Hawkins marble by the favorable opinion expressed in regard to it by Dr. Troost, the former geologist of this State.*

202. In April, 1838, the "Rogersville Marble Company" was formed, by gentlemen in and near Rogersville, for the purpose of "sawing marble, and establishing a marble factory in the vicinity of Rogersville." Orville Rice, Esq., was elected President, and S. D. Mitchell, Secretary. The company operated to a limited extent for several years, erected a mill, and sold several thousand dollars' worth of marble annually, which was mostly distributed in East Tennessee.

In 1844, the company sold out to Mr. Rice, who, on a moderate scale, has perseveringly and successfully carried on the business ever since.†

203. Mr. R. sent a block of the "light mottled strawberry variety" —spoken of farther on, (§ 210,)—to the Washington Monument. This was called the "*Hawkins County Block*," and bears the inscription, "*From Hawkins County, Tennessee.*" Another block of one of the finest varieties, already described, (§ 195,) was sent by act of the Legislature, which was called the "*State Block.*"

204. These blocks attracted the attention of the Building Committee of the Extension of the National Capitol, who, although they had numerous specimens from all parts of the Union before them, decided in favor of the East Tennessee marble.

* We desire to do no one injustice. It is probable that others in East Tennessee are entitled to the credit of having pointed out to the Doctor the location of this and other ranges. If so, we would like to be put in possession of the facts, in order that they may be incorporated hereafter with the rest in the history of marble operations in Tennessee.

† Mr. Rice's elegant residence, "Marble Hall," four miles below Rogersville, is really a museum of the finest marble East Tennessee affords.

We take this opportunity of expressing, both for Prof. B. C. Jillson, of Cumberland University—who was kindly accompanying us at the time of our visit—and for ourselves, our high appreciation of the hospitality and kindness we met with at "Marble Hall."

Mr. Hill, of Rogersville, has also been engaged in marble business for several years. We are under especial obligations to Mr. H. for presenting us with a beautiful inkstand—an elegant specimen of Hawkins County Marble.

An agent was soon after sent by them to ascertain whether or not it could be obtained in quantity, who, when on the ground, had no difficulty in satisfying himself as to this point.

205. As the result of these circumstances, an extensive quarry, affording an excellent material, has been opened at a point about nine miles southwest of Rogersville, where the Holston River intersects the marble range. The rock here is in good part massive, and several hundred feet in width. The location of the quarry is excellent, and admits of the easy transportation of the blocks to the boats. Many thousand cubic feet of marble have already been sent off. It is taken, for a part of its route, down the river, and then by railroad to Charleston or Savannah, where it is shipped for Washington City.

206. The production in Knox county has been considerable, and will rapidly increase.

In 1852, Mr. James Sloan opened a quarry in a range of variegated marble, which, in its south-westward course, runs but little west, or north-west, of Knoxville. This range is many miles in length, affords an unlimited amount of valuable marble, and is intersected by the East Tennessee and Virginia Railroad, and we believe by the Holston.*

Mr. Sloan's quarry is admirably located on a low ridge, being not quite two miles north of Knoxville, and but a few hundred yards from the line of the railroad.

207. From this point all the variegated marble used in our State Capitol has been derived. The amount paid by the State for this marble in its present finished condition, including, however, a few hundred dollars' worth of the "grayish-white" variety, soon to be spoken of, is about $23,000.

Mr. S. is now furnishing variegated marble from the same quarry for the State Capitol of Ohio.

Heretofore the rough blocks have been brought to Nashville, where

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* In addition to this, there are other important ranges of variegated marble, not far from Knoxville.

Previously to 1852, some work had been done toward the practical development of the marble of Knox, but, so far as we can learn, on a limited scale.

this gentleman has quite an extensive steam-power marble factory. He proposes, however, to have another very soon in Knoxville. In the former city, manufactured marble sells at an average price of $4.50 per cubic foot, in the latter at about $3.00.

208. Other quarries have been opened in McMinn and adjoining counties, which we have not had time to visit. We have been informed that they also afford a good quality of marbles. Hereafter we shall aim to examine and report upon them.

2d. *Grayish-White Marble.*

209. This species (as we term it for convenience) may be regarded as a variety of the last. It is, too, a fossiliferous rock, being sometimes called *coralline* or *encrinal* marble, from the fact of its containing fossil *corals* and *crinoids.* (§ 198.) It appears to constitute a distinct member of Formation V., and to occupy a lower place in the series than the variegated bed.

210. In appearance it is a grayish-white, massive sparry rock. The white ground of much of it is mottled with pink or reddish spots. Marble like the latter is found, too, associated with the variegated, and is designated by some as the strawberry variety.

211. A few miles east of Knoxville, there is a fine and valuable quarry of gray marble, belonging to Col. John Williams. The entire thickness of the bed in which it is located is three hundred and seventy-five feet, ninety-five feet of which—near the base of the bed—is massive white marble, and is the portion that is worked. The remainder contains more or less the reddish points or spots spoken of above.

A large amount of marble has been taken from this quarry. Several marble factories in Knoxville have worked it extensively. There is no superior building rock in the State.

212. Five miles east of Knoxville, at Mecklenburg, the residence of our distinguished Tennessee historian, Dr. J. G. M. Ramsey, a beautiful bluff of the light sparry marble is boldly exposed on the French Broad. The upper part is variegated with light flesh-colored points and patches. This mass is as valuable as it is beautiful.

Similar gray marble also occurs about a mile east of Athens, in McMinn. But we cannot now specify further.

3d. *Magnesian Marble.*

213. This species has heretofore attracted little attention. It occurs abundantly in East Tennessee, and, though not as valuable as those we have mentioned, is nevertheless to be regarded with interest. It is found in Claiborne, Hancock, Jefferson, and other counties, imbedded in the upper part of Formation IV. Several ranges of a light-gray variety, banded with pinkish clouds, etc., occur within a few miles of Tazewell.

At Dandridge a light-gray sparry variety, having the same geological position, is worked to a limited extent.

214. The gray rocks of the top part of Formation IV. would doubtless afford, upon examination, in almost every county of the Valley of East Tennessee, a tolerably good marble, and at many points an excellent building material.

4th. *Black Marble.*

215. We have in Tennessee, especially in the extreme eastern counties near the mountains, numerous localities of dark and black limestones, which are susceptible of a good polish, and which may properly be called marble.

These are to be esteemed mostly for the uses made of them in connection with lighter varieties. In the construction of tesselated pavements, or for the bases and capitals of columns, etc., they will be useful, and in fact have been already employed. In numerous cases where contrast is desired they can be used with good effect.

5th. *Breccia and Conglomerate Marble.*

216. We desire to call attention to a beautiful species of marble in East Tennessee, which has not attracted the notice it deserves. This is *breccia marble.*

In the first place, a *breccia** is any rock composed of angular fragments, or at most of fragments but little rounded, firmly cemented in a solid mass. A limestone of this character, if made up of fragments of different colors, or of different shades of color, and susceptible at the same time of a good polish, constitutes a marble which is often very beautiful. A slab of it is in fact a *native mosaic*, the component pieces of which are irregular in outline, and promiscuously arranged.

217. Such marble, of dark colors, occurs in several counties in East Tennessee. We have seen it in Greene, Sevier, Blount, and Monroe.† It may be found, doubtless, near the mountains, or in the coves of all the eastern counties, from the Nolichucky to Georgia, and perhaps, too, in Carter and Johnson.

218. It occurs in elongated patches or narrow bands, and is generally interstratified with slates.

Some care will be necessary in selecting points for the opening of quarries in this breccia, as it frequently contains flinty and slaty fragments, which greatly impair its value. A good test of quality will be its ready susceptibility of a *uniform* and bright polish.

219. Several promising bands, in the mountain and adjoining parts of Blount and Monroe, are intersected by the Tennessee River. We believe that at one or two points work has been commenced upon these, which, however, has not been prosecuted to any extent of practical importance.

It is proposed hereafter to examine further, and with much care, those breccias especially which occur in the mountain regions along the Hiwassee, the Tennessee, the French Broad, etc., as their value is greatly increased by the facilities afforded for transportation.

220. Finally, in addition to the proper breccias, we have observed marble *pudding-stones* or *conglomerates*. In these the component

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* Pronounced *bret'cha*.

† Dr. Troost, in his Fourth Report, referring to the marbles of East Tennessee generally, says: "I have seen there breccia marble which surpasses any that I know." To what particular region or county he may refer in this remark, we cannot ascertain.

fragments are rounded, a polished section necessarily presenting a great variety of *rounded* instead of angular patches.

Marble of this character has been observed near the northern extremity of Star's Mountain, in McMinn, and at several localities, associated with breccias.

SECTION IV.

GREEN-SAND, OR MARL.

221. In Henderson, Hardin, McNairy, Hardeman, etc., in West Tennessee, there occurs a heavy bed of a greenish sandy substance, of great interest. It is often called "*Marl;*" a more appropriate name, however, is *Green-sand.**

222. In our reconnoisance we have met with this substance at many points, and have been astonished at its great abundance. In some regions the bed is nearly three hundred feet in thickness.† Its greatest

* We will use the latter term, in order to distinguish this so-called marl from certain clayey marls found in the district.

† At many points in McNairy and Henderson, ordinary wells sunk in the *green-sand* afford an impure water, too disagreeable to be used. It has been found necessary in such cases to pass entirely through the mass. This is done by boring. A large auger, with a blade or bit five or six inches in diameter, is driven down until, perforating a hard, gritty layer at the base of the mass, it reaches a bed of white or gray quicksand. As soon as this is done, the desired water, of good quality, rises up to within a few feet of the surface.

The perforation thus made, with the exception of a few feet near the surface, needs no protection, the green-sand being compact enough to furnish a permanent wall.

The construction of the buckets used in these wells is peculiar. They are, in fact, mere tubes, made of tin or wood, adapted to the bore of the well—being often three or four feet in length, and but a few inches in diameter. The closed end or bottom is provided with a valve, which opens upward and admits the water freely as the bucket sinks, but closes and retains it as the latter rises.

The success attending the boring of these wells has, at some points in the green-sand regions, nearly or quite doubled the price of land.

Fortunately, many of them have been bored by two intelligent gentlemen, Mr. James W. Saunders, and his brother, who, appreciating the importance of such observations, have kept an account, almost in every case, of the materials passed through, and of the respective thicknesses of the different strata. We have received much valuable information from them.

development is in McNairy. It *crops out*, or appears at the surface, along a band several miles wide, running, most likely, entirely through the eastern part of the county mentioned, and the north-western part of Hardin, into Henderson.

223. From this line of outcrop the great stratum, which it constitutes, appears to dip gently to the west. In Hardeman it may be seen occasionally, occupying a low place in the valleys of the Hatchie and its tributaries. In Henderson, too, its position is low.

224. We do not propose, however, to give any thing like a full account of this valuable material until our investigations are more complete; all we desire to do is to call attention to it. Its value consists in its *fertilizing power;* and it behooves West Tennessee, in behalf of her agricultural interests, to look well to this mineral manure, so bountifully placed at her disposal.

Its transportation to distant points will soon be easy. Two railroads, the Memphis and Charleston, and the Mobile and Ohio, pass through the green-sand region; in fact, some of the excavations along the lines are made in the substance itself.

We will add brief notices of its general appearance, composition, etc., as well as of the estimation in which it is held, and the use made of it elsewhere.

225. *General Appearance and Composition of the Green-sand.*—It has already been called a greenish sandy substance. It is made up of fine sand, a little clay, and an abundance of dark *green grains*, to which its color is due. The latter constitute the characteristic part of the mass. They are soft, crush easily on the nails, and have been compared to the grains of fine gunpowder.

226. As a mass, the green-sand abounds everywhere in great "oyster-shells," of several distinct species, which, though resembling those of existing oysters, are nevertheless different; the species, in fact, to which they belong are now *extinct*. At some points these shells are so numerous that they have been profitably used for making lime.

227. Chemically, green-sand consists mostly of *silica*, *alumina*, *protoxyd of iron*, *potash*, *carbonate of lime*, *and water*. The follow-

ing table will show its principal constituents. Nos. 1, 2, and 3, are analyses of green-sand from McNairy, made by Dr. Troost;* No. 4 is an analysis of green-sand from New Jersey, by Mr. Seybert, of Philadelphia.

No.	Silica.	Alumina.	Protoxyd of Iron.	Potash.	Carbonate of Lime.	Magnesia.	Water.	Loss.
1	48 00	7.00	20.70	10.10	5.70	....	8.00	.50
2	45.30	6.20	18.00	10.40	10.80	....	8.50	.80
3	51.70	6.50	21.20	11.30	2.00	....	7.30	.00
4	49.83	6.00	21.53	10.12	....	1.88	9.80	.89

In addition to these ingredients, it generally contains, no doubt, small amounts of *soda* and *phosphoric acid.*

228. Its *fertilizing properties* have been ascribed by some to the potash, and by others to the small percentage of phosphate it contains. It is most likely due to both.

229. *Its Value and Use in New Jersey.*—In order to call the attention of enterprising farmers in Tennessee to the value of green-sand, we quote the following paragraphs.

Professor George H. Cook, in a late report on the Geology of New Jersey, says in regard to green-sand, "It has been worth millions of dollars to the State in the increased value of the land and produce, besides the influence it has exerted in awakening and fostering a spirit for agricultural improvement."

Again, the value of land affording green-sand simply as an article of traffic, is thus set forth. "Pits ten feet square, and as deep as the purchaser chooses to dig them, are sold for from five to seven dollars. An acre contains" "more than four hundred and thirty-five such pits, worth, at the *lowest* price, $2,175."

230. Professor H. D. Rogers, in one of his reports, published several years since, says:

"Mr. Woolley manured a piece of land in the proportion of two

* Dr. Troost notices the green-sand in his Third and Seventh Reports. In the latter, the quotation (§ 230) from Professor Rogers' Report may also be found.

hundred loads of good stable manure to the acre, applying upon an adjacent tract of the same soil his green-sand, in the ratio of about twenty loads per acre. The crops, which were timothy and clover, were much heavier upon the section which had received the marl, (green-sand;) and there was this additional fact greatly in favor of the fossil manure over the putrescent one, that the soil was also entirely free from weeds, while the stable manure had rendered its own crop very foul.

"There can be no doubt that twenty loads of marl per acre must be regarded as an unnecessarily bountiful dressing; but computing the relative cost of the two manures, when employed in the ratio above stated, we find a considerable disparity in favor of the green-sand. Placing the home value of farmyard manure at one dollar per each two-horse load, and that of the marl at twenty-five cents per load, we have the expense of manuring one acre $200; of marling the same, $5.

"This being an experiment, an extravagantly large dressing of manure was employed, but not exceeding the usual average application more than the twenty loads of marl surpassed what was necessary.

"Experience has already shown that land once amply marled retains its fertility with little diminution for at least ten or twelve years, if care be had not to crop it too severely; while, with all practicable precautions, the stable manure must be renewed at least three times in that interval to maintain in the soil a corresponding degree of vigor.

"At the Squankum pits, which are very extensive, the marl (green-sand) is sold at the rate of thirty-seven and a half cents per load, the purchasers having to dig it. It is transported by wagons to a distance, in some directions, of twenty miles, and retailed, when hauled that far, at the rate of ten, or even twelve and a half cents per bushel, being very profitably spread upon the soil in the small proportion of twenty-five or even twenty bushels to the acre."

231. We trust enough has been said to induce our own farmers, especially those now living within reach of this *native manure*, to test its value. The amount to be used per acre is indicated in the extract

above. If no particular effects are noticed the first year, they may be the second or third. It shall be our aim, as far as may be in our power, to develop its extent, quality, and *practical* importance.

SECTION V.

SALT AND SALT-LIKE PRODUCTS—NATIVE SULPHUR—MINERAL SPRINGS.

232. In this section we refer to the occurrence in Tennessee of *Salt*, *Nitre*, *Alum*, *Epsom Salts*, *Gypsum*, and *Peroxyd of Manganese;* adding, also, paragraphs in regard to *Native Sulphur and Mineral Springs*. Details are mostly reserved for the future.

233. 1*st*. *Salt.*—At several points in Tennessee more or less salt was formerly manufactured. For a number of years back the production has amounted to but little. We believe, however, that promising localities, some of which have been partially tested, but others that we have met with not at all, exist, which may yet prove productive. The manufacture hitherto has been mostly confined to White and Anderson.

234. About the year 1820, Mr. William Simpson, as we are informed, made fifty bushels of salt per day, for months, at the old salt-works on the Calfkiller, in White, three and a half miles north-east of Sparta. After a few months of successful work, the property became involved in a law-suit, which embarrassed and finally stopped operations. The well, three hundred and eighty-six feet deep, commencing in horizontal strata near the base of the *Mountain Limestone*, has been sunk through the *Siliceous Group*, and appears to terminate in the *Black Slate*. When this depth was first reached, large quantities of gas and salt-water were blown out. In about ninety days the gas in good part ceased; after this the water was obtained by pumping.

This property is now in the hands of Gen. J. B. Rogers, who intends to sink the well several hundred feet deeper. We trust his energy and enterprise will meet with the success they deserve.

235. The salt-works of Anderson are situated immediately at the eastern base of the Cumberland Table-land. The well, which is now about one thousand feet in depth, passes through nearly horizontal strata of sandstones, shales, and coal, very near the line of an immense dislocation, which has brought the *coal measures* down to the level of the Valley, and in contact with the shales of *Formation IV.* Such a location is certainly favorable. The water obtained is, however, weak.

The works were formerly in the possession of Capt. M. Winters, but for several years back they had been under the control of the late Mr. Joseph Estabrook,* who, with characteristic energy, had been laboring to make them productive. If this gentleman had been permitted to carry out his plans, he would in all probability have succeeded.

What amount of salt was produced at this point in former years we are not informed.

236. At several other points in East Tennessee, salt-wells have been bored. We desire hereafter to visit them all.

237. Regions in the vicinity of dislocations or great faults in the rocks, like that at the salt-works in Anderson, are certainly the most promising places to look for salt-water. Many of these occur in East Tennessee.

238. 2*d. Nitre, or Saltpetre.*—We have hundreds of *caves* and "*rock-houses*"† in Tennessee, especially along the limestone slopes and in the gorges of the Cumberland Table-land, which afford materials—nitrous earth—for the manufacture of nitre. Some of these were worked many years ago, and will soon be again, most likely. At this time, the price of nitre is, perhaps, sufficiently high to justify operations. In fact, we have been informed that a company has very recently been organized in White county, kettles purchased, and other arrangements made for operations *in the caves* again.

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* We had the pleasure to meet with Mr. Estabrook, in December, 1854, and were delighted with his intelligence and scientific attainments. When we returned, in June, 1855, his house was occupied by others—he had gone to a better world.

† Sheltered places beneath projecting rocks.

239. The efficient principle of the *nitrous* matter, in the earth of these caves, has been derived from the decomposition of animal matter, brought in during ages past by wild animals, and in some cases by man. This efficient principle is *nitric acid,* or simply *aqua-fortis,* which, as slowly formed, has united with the lime or potash of the earth in the caves. Where sufficient potash was present, the product has been at once nitre, (nitrate of potash,) simply needing to be separated from the earth to be fit for use.

This separation is effected by leaching the earthy matter, and evaporating the lye thus obtained; the residuum is saltpetre. When potash is not present, the lye obtained by leaching the earth is charged with *nitrate of lime,* which may be converted into nitre by passing the solution or lye through wood ashes, etc.

240. Most of the saltpetre of commerce comes from India; some from Spain and Egypt.*

241. 3*d. Alum.*—There are numerous localities of *native alum* in Tennessee. Many of our slates and shales contain iron-pyrites,† and when exposed to damp air in sheltered places, as in "rock-houses," etc., often become covered with tufts of alum. This is due to the decomposition of the iron-pyrites in contact with the clay of the slates.

The varieties of alum most abundant are those called *iron* and *feather* alums by mineralogists.

242. One of our formations—the Black Slate—affords a great many localities, especially in Middle Tennessee. It occurs in the "rock-houses" along the valleys and gorges of the streams in DeKalb, Coffee, Franklin, and other counties.

There are many points within the range of this formation where, it appears to us, alum might be profitably manufactured.

243. In East Tennessee there are numerous localities of native alum, especially in the "rock-houses" of the Unaka Mountains. The most interesting one that we have seen, and of which we speak on the next page, is in Sevier.

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* Dana's Manual of Mineralogy.

† A compound of sulphur and iron, sometimes called *mundic.*

244. *4th. Epsom Salt.*—This occurs, often, under circumstances similar to those mentioned with reference to alum.* When decomposing rocks contain both *iron-pyrites* and *magnesia*, *Epsom Salt* (sulphate of magnesia) is often formed spontaneously; it might, too, be manufactured from such materials.

245. The most remarkable locality of Epsom Salt that we have seen is "*Alum Cave*," in Sevier. This cave, situated at a high point on the steep mountain slope of one among a group of the roughest, wildest ranges in the county, is within a few miles of the State line, on the head waters of the West Fork of Little Pigeon, and about south-east from Sevierville.† It is simply a "rock-house," or sheltered place, made by shelving and projecting slates, and running for two or three hundred feet along and up the side of the mountain. Near the upper part of the cave the Epsom Salt occurs in a bank, imbedded more or less in loose earth. From this point, nearly pure and beautiful masses, a cubic foot in volume, have been obtained.

A small amount of this salt has been purified and carried off; the comparative inaccessibility of the locality has perhaps prevented it from being wholly worked up.

Near the lower part of the cave a bank of alum occurs. Beautiful masses of this, greater than a cubic foot in volume, could be obtained.

246. Other localities of Epsom Salt exist in these mountains, and at other points in the Unaka group.

247. The caves of the Cumberland Slopes, also, occasionally afford it, etc.

248. *5th. Gypsum.*—We know of no beds of gypsum within the limits of our State of sufficient extent to be of practical importance. We trust, however, to be able, hereafter, to record the discovery of such beds.

Localities affording elegant cabinet specimens are numerous. The richest that we have met with is *Gray's Cave*, in Sumner county.

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* The same, too, might be said of *copperas*, (sulphate of iron.)

† We are under great obligations to Mr. J. Bradley, of Sevier, for having kindly guided us for two days on an excursion to the cave, and through these mountains.

This locality furnishes fine specimens of the variety called *selenite*, sometimes in beautiful crystals; also, masses of snowy gypsum and elegant "alabaster rosettes."

249. *6th. Oxyd of Manganese.*—This is a black mineral, and in Tennessee is often associated in small quantities with iron ores. It is used largely for making chlorine gas, (§ 157,) which, in combination with lime, is employed in bleaching, and for disinfecting purposes. The pure or nearly pure mineral, in its native state, is worth about $20 a ton.

Dr. Troost, in his Fifth Report, says, "There is," in the northern part of Cocke, near Stone's Creek, "a vein of excellent black oxyd of manganese, which appears to be abundant." We have observed this substance at numerous points, but mostly in limited quantities; valuable deposits, however, are to be looked for.

250. *7th. Native Sulphur*—Small cabinet specimens of native sulphur, associated with quartz, have been met with in Franklin and Macon counties.* The quartz is geodiferous, and occurs in Formation VIII.

251. *8th. Mineral Waters.*—Mineral springs in Tennessee are very numerous and of many varieties. Proposing hereafter to present in a tabular form the principal facts concerning them, we simply now enumerate the most important varieties occurring.

252. In the first place, *Sulphur Springs* abound in all divisions of the State. They occur in several of the limestone formations, but the *Black Slate* is especially prolific, supplying springs for at least a score of frequented watering-places.

253. *Chalybeate Springs*, too, are plentiful, and are found in East, Middle, and West Tennessee. The cool, inviting retreats of the Cumberland Table-land look to these mainly for their supply of mineral water.

254. *Epsom Salt Springs* occasionally occur. Many of our sulphur and chalybeate waters contain more or less *sulphate of magnesia*, which renders them the more efficient.

* Dr. John Owen, of Lebanon, first called our attention to specimens from Macon.

255. *Alum Water* may also be added to the list. An interesting and valuable well of strong alum water has been obtained in a band of the *Black Slate*, in Hawkins.*

Other varieties might be included, but we omit them for the present.

SECTION VI.

HYDRAULIC LIMESTONE, AND OTHER ROCKY PRODUCTS.

256. The last section was devoted to mineral substances, properly so called; in this we enumerate some of the useful *rocks* or *rocky products* of our formations, such as *hydraulic limestone*, *buhrstone and millstone-grit*, *roofing-slate*, *flagstones*, etc., etc.

This section, like the last, is an outline, indicating one direction future work must take.

257. 1*st*. *Hydraulic Limestone.*—Those rocks which will make *hydraulic lime*—so called because it will set and form with sand a hard mortar or cement under water—are generally fine-grained limestones, containing, in variable proportions, a considerable amount of *alumina*, (§ 157,) *silica*, (pure fine sand,) *magnesia*, and sometimes *oxyd of iron*. It is an essential condition that these ingredients be in a very finely divided state, and intimately mixed with the calcareous matter of the limestone. When such limestones are properly burned and ground, the *clay*, *silica*, *magnesia*, *lime*, etc., which they contain, are in a state favorable for chemical combination, and when made into mortar with sand and immersed in water, they, with a portion of water, unite in compounds, which *seal* together all bodies with which they may be in contact.

258. These compounds, to the formation of which the hydraulic character is due, are most likely what chemists call *subsalts*, that is, they contain an excess of the *alkaline* principle; the *carbonic acid*,

* We had an opportunity of seeing this well, through the kindness of Mr. George Powel, of Hawkins, to whose hospitality we are, in addition, much indebted.

the *silica*, the *alumina*, and *water* unite with a *double* proportion of *lime*, *magnesia*, etc., the alkaline ingredients, in forming them. It is, then, to the excess of alkaline and earthy ingredients, like lime, magnesia, etc., that the hydraulic property is to be attributed.*

259. A very heavy bed of hydraulic limestone occurs along the Tennessee River, in Hardin, Wayne, and Decatur. Forming, as it does, the lowest or bottom layer of the horizontal rocks in that region, its thickness has not been ascertained; fifty or sixty feet of it, however, are exposed in some of the bluffs. It is a bluish rock, and beautifully laminated in thin smooth layers.† Some cement was made from it at one point in Hardin, several years ago, which was said to be excellent.

260. Near Knoxville a band of reddish argillaceous limestone has afforded cement of good quality. It has been used successfully in the construction of cisterns, etc., in the city and vicinity.

261. We know of many other beds of limestone which doubtless have hydraulic properties. Investigations are about to be entered upon with reference to them.

262. Large quantities of hydraulic cement are used in Tennessee, but it mostly comes from abroad. We ought to, and it is hoped soon will, manufacture every pound we use.

263. 2*d*. *Buhrstone and Millstone-Grit*.—A superior millstone rock, or *buhrstone*, occurs in abundance a few miles south-east of Tazewell, in Claiborne. Many millstones have already been manufactured from it, which are highly esteemed for making flour, etc. Mr. H. Jones, of Claiborne, is at this time successfully engaged in the business.

The buhrstone occurs in a long band, the *outcropping* edge of a flinty layer, from one to three feet in thickness, dipping to the south-east, in among the upper strata of Formation IV. The quarrying has been done within a few feet of the surface, along the *weathered* edge,

* See Professor J. D. Dana's great work, "System of Mineralogy," fourth edition.
† This stratum or bed has been mistaken for the Black Slate.

which portion doubtless will be found the best. The rock thus obtained is an open, cellular, hard, quartzose chert, the cavities lined more or less with minute crystals of quartz.* We esteem it highly as a buhrstone.

The same rock may be found no doubt for many miles along the same range.

264. Another band like it, having the same geological position, occurs on the opposite side of Tazewell.

The manufacture of good millstones in Claiborne might be carried on to much greater extent than it is at present.

265. Bands of buhrstone, similar to those of Claiborne, are found, and have been worked, in Jefferson, Knox, and perhaps other counties. They may be looked for at numerous points.

266. The Siliceous Group affords, in Middle Tennessee, several millstone quarries, as in Sumner, Davidson, etc. Dr. Troost, in his Third Report, speaks of a "superior kind" of "siliceous millstone" near Harpeth River. We have not had an opportunity of examining it.

267. We apply the name *millstone-grit* to coarse, hard sandstones, containing siliceous pebbles. There are many points in Tennessee where millstones, suitable for grinding corn, and occasionally flour, have been obtained from such rocks. The grits of the coal measures especially are often quarried for this purpose.

268. In Crab Orchard, Carter county, a hard gray *syenitic gneiss* (a granite-like rock) has been used for millstones.

In Johnson an allied rock (common gneiss) is used.

269. 3*d*. *Roofing-Slate.*—Not among the least important of our rocky products is *roofing-slate*. The superiority of slates for roofing, especially in large town and cities, will surely create in Tennessee, at no very distant day, a demand for them.

270. In the mountain parts of Polk, Monroe,† Blount, Sevier,

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* We noticed in some of these cavities small but elegant crystals of *pearl spar*. Some distance below the surface, the cavities will most likely be found filled with *dolomite*, etc.

† We are indebted to the kindness of Col. M. F Johnson, of Tellico, for pointing out to us, among other favors, localities of roofing-slate in the vicinity of the Iron-works.

Cocke, etc., great ranges of roofing-slates abound. We have seen them at many points, and of good quality. They occur within the range of Formation II. The facts we have collected in reference to these slates will be embodied in a more complete account hereafter.

271. Dr. Troost, in his Sixth Report, thus speaks of one of the bands of roofing-slate found in the south-eastern part of Sevier: "This is a very extensive tract of slate, and from the superficial examination to which I could subject it, no quarries having yet been made in it, seems to be of an excellent quality. I have seen slabs of it, which have been detached by some natural cause, from ten to twelve feet square, and of uniform thickness, perfectly level and sonorous."

272. Slate used for roofing is generally of a dark-bluish or purplish color. The color is not, however, important. "To be a good material for roofing, it should split easily into even slates, and admit of being pierced for nails without fracturing. Moreover, it should not be absorbent of water, either by the surface or edges, which may be tested by weighing, after immersion for a while in water. It should also be free from pyrites, and every thing that can undergo decomposition on exposure."*

273. *4th. Flagging-Stones.*—When rocks split readily into thin, smooth layers or *slabs*, a few inches thick, they are called *flagging-stones*, and are used for paving.

Such flags or slabs, of good quality, are greatly in demand in cities and large towns, and a quarry of them, favorably located for their transportation, is often very valuable. As an evidence of their value, we refer to the fact that in Nashville now, as a substitute, large masses of limestone are slowly *sawed*, at comparatively great expense, into paving-stones.

274. Excellent sandstone flags occur in Morgan, not far from Montgomery. A railroad may some day bring them within reach of a market. Quarries of tolerably good flags might be opened in the hydraulic limestone of Hardin, etc. (§ 259.)

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* Dana's Manual of Mineralogy.

Many of the slates of the eastern mountains could afford good flagging materials.

The thin limestones of many regions are now used, but they are by no means equal to our best flagstones. When the internal improvement system of Tennessee is more complete, those of superior quality will be made accessible.

275. *5th and Lastly, Sands for Glass-making, Potter's and Fire Clays, Building Materials, Grindstones, Whetstones, Fire Rock, etc.*, are additional products, which have been noticed in greater or less abundance, and in many cases of excellent quality, in different parts of the State. We cannot now enter into details. They all properly demand a share of attention, and must receive it.

SECTION VII.

METEORITES.

276. *The Lincoln Meteorite.*—Within a few months, another small meteoric mass has been added to the list of those extra-terrestrial bodies which have fallen within the limits of Tennessee. This recent visitor is a stone, weighing, when first obtained, three pounds.

A highly esteemed friend, the Rev. T. C. Blake, of Cumberland University, to whose zeal we owe a knowledge of this interesting specimen, has furnished us with the following particulars in regard to its history.

277. It fell two miles west of Petersburg, and fifteen north-west of Fayetteville, in Lincoln county, about half-past three o'clock, P. M., August 5th, 1855, during, or just before, a severe rain-storm. Its fall was preceded by a loud report, resembling that of a large cannon, followed by four or five less reports; these were heard by many persons in the surrounding country. Immediately after, this mass or fragment was seen by James B. Dooley, Esq., to fall to the ground. It approached him from the east, appeared, while falling, to be surrounded by a "milky" halo, two feet in diameter, and fell one hundred

and fifty or two hundred yards from him, burying itself about eighteen inches in the soil. When first dug out, it was too hot to be handled.

278. This specimen, which now lies before us, has an edge broken off, revealing the character of the interior. Within it is of an ashen-gray color, varied by patches of white, yellowish, and dark minerals. (§ 283.)

With the exception of the broken edge, it is covered, and when first obtained was entirely covered, as most meteorites of this kind are, with a very thin "black, shining crust, as if it had been coated with pitch;" this was doubtless formed by the fusion of its outer surface in its rapid passage through the air.

279. One end or face, which may be regarded as the base, has an irregular rhomboidal outline, averaging 2¾ by 2½ inches. Placing the stone upon this end, the body of it presents the form of an irregular, slightly oblique, rhomboidal prism. The upper end, however, is not well defined, but runs up to one side in a flattened protuberance, giving the entire specimen a form approaching roughly an oblique pyramid. The length from the base to the apex is 4½ inches.

280. Three adjacent sides are rough, being covered with cavities and pits. It is likely that the stone has been torn off from a larger mass, or from other fragments, along these faces.

The other sides are smoother and rounded, and appear to have constituted a portion of the surface of the larger mass.

281. The specimen acts upon the needle; fragments of it readily yield particles of nickeliferous iron by trituration in a mortar. The specific gravity of the entire specimen is 3·20. Its weight, in its present condition, 3·83 lbs.

282. Professor J. Lawrence Smith, of the Medical Department of the University of Louisville, has analyzed fragments of this meteorite, and has kindly furnished us with a copy of the result.

283. The minerals found in the meteorite are:—

"Pyroxene—principal portion of the mass;

Olivine and Orthoclase, } —disseminated through the mass;

Nickeliferous iron—forming about one half per cent. of the mass.

In addition to these, there are specks of a black, shining mineral, not yet examined."

The general analysis is as follows:—

Silica	49·21
Alumina	11·05
Protoxyd of iron	20·41
Lime	9·01
Magnesia	8·13
Manganese	·04
Iron	·50
Nickel	trace.
Phosphorus	trace.
Sulphur	·06
Soda	·82
	99·23

284. *Tennessee Meteorites in General.**—There are now *three* distinct Tennessee meteorites the time of the falling of which is known. Besides these, many others have been discovered and described, known, from their characters, to be of the same origin.† Our State has proved itself remarkably rich in these wonderful messengers from the sky.

* A distinction is sometimes made between *meteorites* and *aerolites*, which we have disregarded

† We add a note in regard to the *general character and origin of these strange bodies.*

Meteorites, in the first place, are remarkable for containing *malleable iron;* some are almost wholly made up of it; others are stony in appearance, but yet contain more or less iron in particles, etc., disseminated through their masses. They contain, too, other free metals, especially nickel, and minerals not found in terrestrial bodies.

These characters link them together; indicate a common origin; "and, at the same time, separate them from every thing terrestrial." Their source must be looked for beyond the earth.

The three most important theories which have been proposed to account for them, are the following:—

1st. *They are derived or thrown off from "terrestrial comets," of comparatively small size, "revolving about the earth like the moon."* This theory supposes these bodies or comets to come occasionally in contact with the atmosphere of the earth; the condensation of the air, produced by their immense velocity, causes the evolution of great heat, inflaming them at their surfaces, and disengaging gases, which, together with the unequal action of the heat upon the masses, produce explosions. In this way glowing fragments are detached, and fall to the earth, while the larger bodies may pass onward in their course. In some cases they may be entirely broken into fragments, all of which fall.

2d. *They are derived or thrown off from bodies similar to the last, but revolving around*

For the benefit of those who desire such information, we add a table of all, so far as we know, that have been described.

TABLE OF TENNESSEE METEORITES.

No.	County in which found.	General character.	Weight.	Time of falling.	By whom and when described.	Through whom made known.
1	Sumner.	Stony.	11 lbs.	May 9, '27	Seybert.	
2	Cocke.	Malleable iron.	2000 "	Unknown	Troost, 1840.	Hon. Jacob Peck.
3	Dickson.	"	9 "	July or Aug. 1835.	" 1845.	J. Voorhies, Esq.
4	Greene.	"	20 "	Unknown	" 1845.	Mr. Joseph Estabrook and Hon. Jacob Peck.
5	DeKalb.	"	36 "	"	" 1845.	
6	Jackson.	"	15 oz.	"	" 1846.	Col. S. D. Morgan.
7	Smith.	"	280 lbs.	"	" 1846.	" "
8	Rutherford.	"	19 "	"	" 1848.	
9?	Jefferson.	"	2¼ "	"	Shepard, 1854.	Hon. Jacob Peck.
10	Claiborne.	"	60 "	"	Shepard, 1854, and Smith, 1855.	Prof. J. B. Mitchell.
11	Campbell.	"	4¼ oz.	"	Smith, 1855.	" "
12	Lincoln.	Stony.	3 lbs.	Aug. 5, '55	Smith, 1856, and Safford, 1856.	Prof. T. C. Blake.

the sun like the planets. In this case, too, they are conceived to come in contact with the atmosphere, producing the same phenomena of condensation, heat, explosion, falling of glowing fragments, etc., to which we have just referred.

3d. This theory regards them *as having been thrown off from the moon, by volcanic action, with a velocity sufficient to carry them beyond her preponderating attraction, into that of the earth.* In this case the motions of many of the meteorites would be such as to cause them to revolve for a time around, or partly around, the earth, until, becoming entangled in the atmosphere, and checked in their courses, they fall, producing, at the same time, the effects of heat, explosion, etc.

This view of their origin has been advocated by many distinguished mathematicians and philosophers.

In regard to the mineral and volcanic character of the moon, we quote, in conclusion, the following from an able memoir on meteorites, by Professor J. Lawrence Smith.* "It cannot be doubted, from what we know of the moon, that it is, in all likelihood, constituted of such matter as composes meteoric stones, and that its appearances indicate volcanic action, which, when compared with the combined volcanic action on the surface of the globe, is like contrasting Ætna with an ordinary forge, so great is the difference. The results of volcanic throws and outbursts of lava are seen, for which we seek in vain any thing but a faint picture on the surface of our earth."

* See Journal of Science, 2d series, vol. xix.

CHAPTER V.

THE GEOLOGICAL STRUCTURE OF TENNESSEE.

285. For many reasons, it is highly important that the geological structure of the State should be known and understood. Knowledge of this kind, in addition to other important but less practical considerations, explains many of the apparent anomalies which often present difficulties to the miner; it enables us to trace out, with facility and precision, beds of coal, iron ore, etc., and guides us often, when no other clew exists, to the very spot where they may be found; it aids in determining the extent, position, range, etc., of veins and mineral deposits, and points out the most economical plan of reaching and securing their contents; it is, in fine, indispensable to the successful development of any mineral region.

SECTION I.

THE STRATIFIED CONDITION OF THE ROCKS, AND THE GROUPING OF THEM IN FORMATIONS.

286. *The Rocks Occurring in Layers or Strata.*—It may be said, generally, that all the rocks *in Tennessee,* including the sands and clays of the Western Division, are disposed or arranged in *layers* or *strata.* For this reason they are said to be *stratified.*

287. The exceptions are very limited. They consist of mineral veins and *dikes,* or large veins of a greenish volcanic rock—called *greenstone*—intruded, when in a melted state, into the rents and fis-

sures of the stratified rocks. Such dikes occur in Crab Orchard, Carter county.

288. The rocky sheets, or strata, are of all thicknesses, from that of mere leaves, as in the case of many slates, up to that of heavy beds, fifty or a hundred feet thick.

289. *The Grouping of the Strata into Formations.*—We often meet with a series of adjacent strata similar in many respects, so much so that they can conveniently be thrown together in a single *group* or *formation*, as such a series is often termed. Our Tennessee rocks are thus grouped, in this report, into *fourteen formations*,* the strata which compose each one having certain common *characters*.

290. For example, the *sandstones*, *slates*, and *coal*, which form the upper part of the Cumberland Table-land, are grouped in a *formation*, called the *Coal Measures*, with the following among other common characters: *First*, coal is found at intervals throughout the series; *secondly*, there is very little limestone, or calcareous matter, in the series; *thirdly*, the strata are parallel, and appear to have been formed in succession, under similar circumstances; *fourthly*, the same *fossils*, such as different species of petrified shells, leaves, branches, and trunks of trees, etc., occur, imbedded in the rocks, throughout the length and breadth of the series. *Characters* similar to these unite the strata of all the formations.

The character last mentioned we must refer to more particularly, on account of its great importance in designating with precision the group to which local and isolated beds of rock belong.

291. *Fossils and their Use.*—With the exception of the first two, all the formations adopted contain *fossils* or petrifactions of some sort; in fact, certain limestones are mostly made up of them.

"The dust we tread upon was once alive!"

They are, generally, parts of petrified plants, shells, corals, crustaceous animals; sometimes the teeth and bones of fishes, and even of quadrupeds. With but few exceptions, they are the remains of ani-

* See the table at the end of this chapter.

mals and plants which *do not exist* at present upon the globe. The part of Geology which treats of them is called *Palæontology*.

292. Now, it is not a little singular that every formation has, in great part, its own fossils. ***Most of those found in one do not occur in any other.*** Upon this fact depends their great utility. They furnish, when known well enough to be recognized, unmistakable evidence of the geological position, and hence the general character, of the formation in which they are found. By means of them, for example, it is often easy for a geologist, travelling in a country wholly unexplored, to know certainly when he is in the midst of a coal-region, without having seen otherwise a trace of coal. The shells in the limestone, the fossil branch or trunk in the sandstones, the leaf-impressions in the slates, he recognizes at once as those belonging to the rocks associated with and including the layers of coal; they can belong nowhere else in the geological series, and better evidence of the presence of coal-bearing rocks is not required.

Many similar examples, showing the practical utility of these natural *indices*, might be given, but we deem it unnecessary.

293. *Extent of the Formations.*—The formations are generally of wonderful extent. The great rocky and comparatively very thin sheets, one upon another, spread over often thousands of square miles. A few examples will illustrate this.

294. One of our formations is a *black slate*, not at any point much over a hundred feet in thickness. This formation is found in the western part of the State, cropping out along the hills on both sides of the Tennessee River. Going eastward, it appears again all around the slopes of the Central Basin; runs under the Cumberland Table-land, and issues from beneath the mountain in Sequatchee Valley; thence it runs under Walden's Ridge and Lookout Mountain, and reäppears at the base of the Cumberland, (Walden's Ridge in part,) all along its eastern slope, with but few interruptions, from Georgia to Virginia. We find it, too, as far east as the narrow valley which lies along the eastern base of Clinch Mountain, as well as in the vicinity of Montvale Springs, in Monroe.

It thus extends, though comparatively very thin, almost from one end of the State to the other, always occupying, too, the same relative position with reference to the formations above and below.*

295. That immediately above the Black Slate—which is a very different rock— is equally as extensive. So it is, more or less, with all of them.

296. The *soft rocks*, or, in other words, the *clays* and *sands* of the "District," though not reaching eastward beyond the Tennessee, spread out southward to great extent, and are found in Mississippi, Alabama, etc.

297. The formations, however, though extensive, exist in a more or less *fragmentary condition*, having been *much cut up* by the action of water in the excavation of basins, valleys, etc.; they have, too, in East Tennessee, been *folded* and *displaced* by great disturbing forces. These characters we shall refer to more particularly farther on.

298. *Originally*, all the formations—excepting those of the *soft rocks* just mentioned, and all allied beds and deposits which, having been formed, geologically speaking, recently, form a *younger class* by themselves—were once, doubtless, *unbroken*, *continuous*, and comparatively *horizontal* and *conformable*, over the whole State.† They thus appear to have originated, in part, under like conditions.

SECTION II.

THE ORIGIN OF THE FORMATIONS.

299. 1*st*. *The Origin of the Older Class of Formations.*—In view of what has been said, the *older class* of formations (compare § 298)—embracing those from the lowest to the *Coal Measures* inclusive—have been

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* In addition to its east and west extent, it spreads out north and south, extending from Alabama through Tennessee, Kentucky, and Virginia, into Ohio and Pennsylvania, etc.

† We ought, perhaps, to except, in part, Formation VI., which is not found along the eastern side of the Central Basin, thereby causing Formation VII. to rest upon V. It occurs, however, in its proper place at most other points.

apparently formed under circumstances in many respects similar. Their undoubted and remarkable marine character, containing often, as they do—excluding Nos. I. and II.—myriads of sea-shells, corals, sea-weeds, etc., (§ 291,) indicates their origin, and, together with the fact that just such limestones, sandstones, etc., as compose them are *now* forming in our present seas, compels us to believe that they too were formed—at a much lower level than they now have—beneath the surface of some great sea. That such a sea or ocean did exist, covering, not only the area occupied by Tennessee, but a good part of the Union, there can be but little question.

300. The character of the matter, sediment, etc., brought from the unknown (but perhaps *eastern*) lands, which then existed, into this ancient ocean, was different at different times; occasionally it was argillaceous mud, which, settling to the bottom, in time became slate; again, it was sandy matter, affording the materials of a sandstone; at another time, calcareous matter, the deposition of which furnished the elements of a hard limestone; or it was composed of two or all of these, in varying proportions, the stratified deposits of which ultimately hardened into sandy limestones, argillaceous sandstones, and other mixed rocks.*

301. Thus these formations were deposited successively in the order in which we now find them, each the product and representative of a certain long period—being, in fact, a *stony record* of the kind and condition of marine life, and of the physical condition of the ocean, and even, in some cases, of the lands at the time.

302. They have been elevated to their present inland position by

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* The deposition of the matter constituting the uppermost of the older class of formations—the Coal Series, which has a twofold character, some of its layers bearing fresh-water and terrestrial marks, and others marine—took place perhaps when this ancient ocean was comparatively shallow, and its bottom, at the same time, subject to slow alternate elevation and depression, giving sometimes land and sometimes sea. When land existed, beds of vegetable matter accumulated, either in vast swamps, or otherwise; when the sea prevailed, these beds were flooded and covered with layers of mud and sand. Thus alternately may have been formed the strata which have since become the coal, slate, and sandstones of our coal measures.

It may appear strange to some that we speak so freely of the *elevation* and *depression*

the gradual, or sudden it may be, upheaval of the land, and the consequent retiring of the sea.

303. 2*d*. *Origin of the Sands and Clays of West Tennessee.*—The formations peculiar to West Tennessee, or those of the *soft rocks*, (§ 298,) were formed long after the others had been raised from their mother ocean. Nevertheless, the materials of these two were deposited from water.

304. The Atlantic appears at one time, owing to the lower level which the Southern States once had, to have covered a wide strip of country next the sea-board, from Virginia around to Texas, and to have extended in an arm up the Mississippi basin nearly as far as the mouth of the Ohio. Almost the whole of West Tennessee, and a great extent of country beyond the Mississippi, was thus covered.

Then it was that the *sands* and *clays* (Formation XI.) were deposited; then too the shell-fish, the remains of which now constitute the great "shell-banks" (see § 226) of McNairy and adjoining counties, lived and flourished in their sea-water home.

305. Afterward, from the gradual upheaval of the land, and the consequent retiring of the sea, the width of this arm was contracted; it covered, then, not quite half the District. At the same time the fresh water from the North began to prevail, and soon expelled that of the sea, or, in other words, the Mississippi, with a "wide lake-like expansion"—perhaps a hundred miles or more in width—occupied its place.

Then were deposited continuously over the whole area covered by

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of land. It is, nevertheless, in perfect accordance with what is now occurring in nature. Although our own coasts are, at this time, stable—although no changes in the relative level of land and sea have been observed with reference to *them* for the last three hundred years, yet no reason can be assigned why, long before, they might not have occurred.

It is certainly true that just such movements are *now* going on at many points upon the globe. It has been demonstrated that six hundred miles of the west coast of Greenland has been slowly sinking for the last four centuries, and that what was once dry land is now sea-bottom. On the other hand, parts of Sweden are experiencing a contrary movement. Many like examples of *upheaval* and *subsidence*, known to have taken place, or to be taking place, might be mentioned.

the fresh water, the sands, loam, etc., remnants of which now compose the "Bluff." (§ 40.)

306. By still further upheaval, the waters of the Mississippi were drawn into narrow limits, and, with increased velocity and greater power, commenced the work of carving out, or excavating from the sandy and loamy strata last formed, the present great Valley, many miles wide, in which are the low "bottoms" and the ever-changing channel of the river.

307. Remnants of the strata removed, as above implied, crop out along the "Bluff," and run back eastward to the second range of counties parallel with the Mississippi.

308. The *bottoms* have been formed, removed, and formed again, time after time, during the progress of the greater excavation just described, and are still subject to the same changes.

SECTION III.

THE PARTIAL REMOVAL OF THE FORMATIONS BY WATER, OR THEIR DENUDATION IN MIDDLE AND WEST TENNESSEE.

309. The cutting and washing away, or, as geologists express it, the *denudation* of certain strata by the Mississippi, has just been referred to. (§ 306.) The *older rocks* (§ 299) present examples of such excavating and removal on a stupendous scale. The agent has been water, but when and how it acted to effect these results it is difficult to tell. Many of the small valleys have doubtless been cut out by the streams which flow through them, but there are no *existing* causes to which can be referred the excavation of the great rocky basins of Tennessee and adjoining States. Most likely the greater part has been done by oceanic currents just before or during the time of the upheaval of the formations. (§ 302.)

310. The denudation of the formations in *Middle* and *West Tennessee* is more easily understood than that of the formations farther east. In the former divisions the rocks are *comparatively* horizontal;

but in East Tennessee they have been *folded*, as before stated, (§ 297,) and thrown upon their edges, thereby complicating its geological structure. We shall refer to the latter division presently.

311. The *Central Basin*, which we have already described, (see § 35 and map) is a beautiful example of *denudation*. It has been carved out of *four* formations; three of these (Nos. VIII., VII., and VI.) have been entirely cut through, and the lowest (V.) deeply cut into. Originally when continuous the strata rose up in a slightly elevated *dome*, the summit of which was over the central part of Rutherford county. If we take the formation (No. VIII.) of the flat highlands around the Basin as the topmost of the dome, the amount of matter removed at this point could not have been less, in vertical thickness, than 1200 feet. The lowest layers of limestone in Middle Tennessee occur here.

312. Throughout the Basin, remnants of the strata removed, always occupying the same relative position, may be seen in the hills and ridges. Around its sides, too, they crop out in well-defined and uniform order.

Farther west, the Tennessee has cut out a valley through or nearly through three of the same formations, etc., etc.

313. But these examples are of small extent when we come to regard the vast denudation which preceded, and which swept away the formations above those out of which the Central Basin and the valley mentioned were excavated.

The two formations of the Cumberland Mountain or Table-land—the Coal Measures above and the Mountain Limestone below—once spreading out westward, covered the whole of Middle and West Tennessee, and connected toward the north-east in Kentucky with the same formations of the "Illinois" coal-field. Of the *first*—this great expanse of Coal Measures—with the exception of the extensive remnant in the Table-land, and a few inconsiderable fragments or outliers near by, nothing now remains in Tennessee; by far the greater part has been swept away, most likely before the power of submarine rivers.

314. The Mountain Limestone, too, has disappeared to great extent.

Patches of it remain on the high grounds between the Central Basin and the Tennessee. It is found in Robertson, Montgomery, and Stewart, from which counties it runs northward, and finally disappears beneath the Coal Measures of Western Kentucky.

SECTION IV.

THE FOLDING, DISLOCATION, DENUDATION, AND METAMORPHISM OF THE FORMATIONS IN EAST TENNESSEE.

1st. *The Folding, Dislocation, and Denudation, in the Cumberland or Western Portion.*

315. The strata along the western portion of the Cumberland Table-land, though much cut up by the action of water, are flat and otherwise undisturbed. They retain their horizontal position for many miles eastward.

Approaching the eastern limit of the Table-land, however, we meet with traces of a remarkable action. The rocky layers begin to lose their horizontal character, and to exhibit clear evidences of having been crowded up in *long straight folds*, running generally north-east and south-west.

316. For example, the ridge called *Crab Orchard Mountain*, (§ 27,) is nothing more nor less than the nearly *unbroken back* of one end of such a fold. A section of the mountain or ridge, and of the fold at this point, is included in the general section, at the bottom of the map. This is the first well-defined disturbance of the kind met with, and, as a beautiful example of the movements to which the rocks in East Tennessee have been subjected, we will trace it out and speak of it in some detail. We designate it throughout its entire length as

317. *The Sequatchee Fold.*—It commences, perhaps, near the Emery River in Morgan, and, running in a straight line south-westward, forms the mountain of which we have spoken, and all the high points between it and the head of Sequatchee Valley. At "Crab Orchard House" it

is intersected by a gap, which furnishes a pass for the Sparta and Kingston road, and, at the same time, exposes the Mountain Limestone, *elevated by the fold* above the general level of the Table-land.

318. A few miles farther south-west there is another break or depression, called *Grassy Cove*, which also exposes the limestone.

319. But this is by no means the extent of this curious fold. The whole of *Sequatchee Valley* originated from it, and has been excavated along its summit. Most likely the strata of the Sequatchee portion, which is greater and wider than that farther north, instead of forming a ridge like Crab Orchard, were rent open in a great longitudinal fissure, thus exposing the rocks to the denuding power of water, and originating the valley.

320. The diagram below has been constructed to illustrate, among other things, the character of this fold, (indicated by the curved lines A, B, C, etc.,) and the relation that Sequatchee Valley (the depression between A and C) sustains to it.

SECTION FROM THE CUMBERLAND, EIGHT MILES NORTH OF JASPER, TO THE EASTERN BASE OF LOOKOUT MOUNTAIN.

(Length of Section twenty miles; Vertical Scale about five thousand feet to the inch.)

A and C, High edges respectively of the Cumberland and Walden's Ridge, overlooking Sequatchee Valley, represented by the depression between. D, Narrow Valley of the Tennessee River; the section crosses a few miles above Kelly's Ferry. E, Portion of the Walden's Ridge and Raccoon Range cut off by the river, etc. L, Lookout Mountain. Depression between E and L, Valley of Lookout Creek.

The formations can be made out by reference to the table at the end of this chapter. The unbroken lines represent the formations as they actually occur. The broken lines indicate the elevation of the folds, and the amount of matter removed by denudation. (§ 319.) B, Summit of the restored Sequatchee fold. I, I, Converging lines, indicating a section of the supposed fissure or rent. F, Summit of *another smaller fold*, the denudation of which has formed the Valley of Lookout Creek.

321. As the *fold* approaches Sequatchee Valley from the north-east, it curves a little eastward, and then continues, in a straight course, to the Alabama line. It does not, however, stop here.

322. Entering Alabama, and curving at the same time slightly west, it extends south-westward for about one hundred miles, terminating finally, as it commenced, in the very bosom of the Coal Measures.*

The portion in Alabama is much denuded, affording what may be regarded as the extension of Sequatchee Valley.†

323. Thus, finally, Crab Orchard Mountain, Grassy Cove, Sequatchee Valley, and its Alabama extension, all belong to this almost straight fold, nearly or quite two hundred miles long.‡

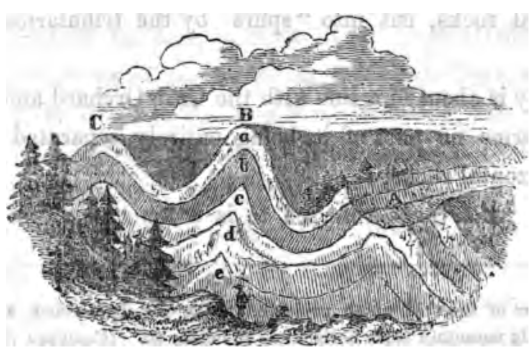
* This at least must be the case according to Prof. Tuomey's Map of Alabama, 1849.

† The Tennessee River, breaking through the mountains, Walden's Ridge, etc., (§ 29,) into this long trough, just within the limits of our State, and turning at the same time south-westward, enters Alabama, and flows along the denuded range for nearly sixty miles, when it again turns and escapes to the west.

The stream which flows through Sequatchee, and which, too, bears its name, empties into the Tennessee, just before the latter river leaves the State.

‡ The following cut, including also a section of the Swiss Jura, taken from Sir Charles Lyell's excellent Manual of Elementary Geology, will be useful in illustrating similar foldings, and the structure of certain valleys and ridges in East Tennessee.

CUT AND SECTION ILLUSTRATING THE FOLDING OF THE ROCKS, AND THE STRUCTURE OF THE VALLEYS AND RIDGES THEREBY FORMED.



a, b, c, d, e, Great rocky layers, or formations, which by lateral pressure have been crowded up into the folds A, B, and C. Both B and C are unbroken and undenuded, forming long straight ridges. A, however, has been fractured and denuded along its summit; thus a trough or valley has been formed along the line of elevation.

The structure of Sequatchee Valley resembles that of the trough A. The former valley has, however, been subjected to much greater and deeper denudation, removing

324. *The Elk Fork Half-fold, or Dislocation.*—In going eastward across the Table-land, near the Kentucky line, the *first* indication of a disturbance met with occurs along the *Valley of the Elk Fork*, a tributary of the Clear Fork of Cumberland. We have already spoken of this valley, in connection with the "dyestone" iron ore it affords, (§ 74,) and we refer to it now as another example of the movements to which the formations have been subjected. It commences *abruptly* at a point called "*Elk Gap*," in the very midst of high mountains, and about eleven miles, a few degrees north of west, from Jacksboro'. From this point it runs north-eastward into Kentucky.

325. The formations here have been elevated in a broken or *half-fold*. Instead of rising up in a complete rounded arch, they have been fractured along the line of elevation, the eastern side alone rising up in the long bold *Pine Mountain*, exposing at its base, in the upper half of the valley at least, the first four or five formations below the Coal Measures. The *western* side remains behind, presenting nothing in the valley but the horizontal sandstones and shales of the Coal Series. In this way the Dyestone Group and the Coal Measures have been brought in contact, along what we will call a line of *dislocation.*

326. The valley is narrow. Its eastern side is well defined by the nearly straight Pine Mountain; the western, on the other hand, has its horizontal rocks, cut into "spurs" by the tributaries of the Elk Fork.

This valley is about in a line with the Crab Orchard and Sequatchee Fold, but forms no part of it, being entirely separated by a great area of horizontal rocks.

327. The "*Elk Gap*" referred to is a low "pass," connecting the

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entirely the part of the fold which projected above the Table-land, and leaving the formations of its mountain sides horizontal, or nearly so. (Compare Section on page 138.)

The valley between A and B has a geological structure very different from that at C, being included and constituting the trough between two great folds. Many of our East Tennessee valleys have been thus formed. A section of two of them, in Washington, has been given on page 38, which may be compared with this; many other examples might be adduced.

heads of two valleys, the one we have just described, and *that of Cove Creek.* These valleys, thus originating at the same point, run off nearly at right angles to each other. The latter is very narrow, being a straight, deep cut, scarcely entitled to the name of valley. It opens below into the south-western end of Powell's Valley—a beautiful, narrow limestone depression, which winds along the base of the mountain into Virginia.*

328. The *Valley of Cove Creek* has been formed by a *dislocation*, like that of the Elk Fork, but of much less magnitude. It has, too, on its north-eastern side, a sharp roof-like ridge, corresponding with Pine Mountain, but not as high, and mostly made up of sandstones, highly inclined. This remarkable ridge, as it escapes from the narrow valley, curves around to the north-east, and skirts the main mountain into Virginia. Powell's Valley is thus cut off from the body of the Cumberland, though running near and parallel with it. (See § 29.)

329. The dislocation along the Elk Fork, extending, however, beyond the mouth of this stream into Kentucky, and that along Cove Creek, cut off from the main Cumberland a great block or table, averaging more than twelve miles across, and running lengthwise many miles north-eastward, beyond the State. (See the Map.) To the lateral movement of this great mass, due to the pressure of some vast power exerted from the east, is, most likely, to be attributed the fractures and dislocations of the rocks in the two valleys, as well as the upturning of the strata in the long Pine Mountain, etc.

330. The Sequatchee Fold, and the broken or half-folds of the Elk Fork and of Cove Creek, are the only disturbances of that kind that we have observed within the area of the Table-land.

The great bed of mountains between the narrow valley of Cove Creek and the Emery River (see § 27) are composed of the horizontal strata of the Coal Measures, and appear to have effectually resisted the folding and dislocating power.

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* The valley of Cove Creek, and that of the Elk Fork, afford an excellent and truly wonderful cut through the Cumberland for a railroad, connecting East Tennessee with Kentucky.

331. *The Eastern Bluff Slope of the Table-land.*—The eastern slope and crest of the Cumberland Table-land is composed, generally, of the upturned edges of the formations. The strata are horizontal, back, but approaching the slope they curve more or less upwards—sometimes even becoming vertical—and form the sharp crest which so distinctly defines the Cumberland on the east.*

The sandstones of the Coal Measures generally form the upper part of the slope, while the Mountain Limestone, the Siliceous Group, the Black Slate, and the Dyestone Group—formations noticed in the next chapter—crop out along its base.

Sometimes fragments of the Coal Measures are thrown over the crest, and lie along the slope, or horizontal in the Valley. Such fragments afford coal at several points in East Tennessee.

332. In the northern part of the State, the crest formed by the upturned edges of the rocks is mostly detached from the horizontal strata of the mountain back by narrow valleys, forming the sharp ridges of which we have spoken. (§§ 29 and 328.) The portion of the Cove Creek Ridge skirting the mountain, west of Powell's Valley, as well as the similar ridge which runs around the undisturbed mountain-bed farther south, are thus included.

2d. *The Folding, Dislocation, and Denudation of the Formations in the Valley, and in the Unaka or Eastern Portion.*

333. Entering the *Valley of East Tennessee*, the *foldings* and *dislocations* become enormous, and occur in rapid succession. Within the Table-land they are few in number and limited in extent; but *here* they have determined the character of the entire Division. They have given *direction* and, in part, *form* to the hundreds of valleys and ridges which make up its *fluted* area.

We will not attempt to enumerate them. All we propose to do, at present, is to point out, in general terms, how they enter into the

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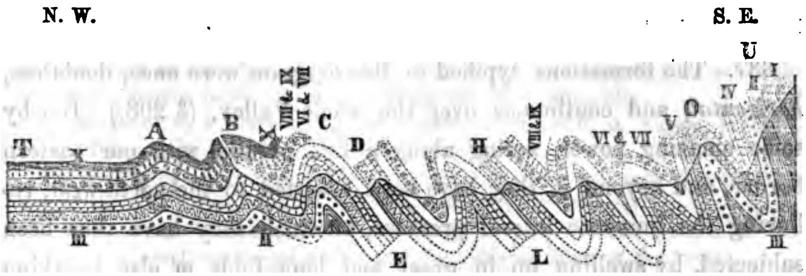
* Sections of the eastern slope of the Cumberland are seen at A, in the diagram on page 42, at E, in that on page 138, at B, on page 143, and on the Map.

structure of this beautiful valley, and, in connection with it, that of the mountains on both sides; thus reviewing, in part, what has been already said in regard to the folds and dislocations of the Cumberland Table-land.

334. The following general section, from the Cumberland to the Unaka, cutting directly across and through the Valley, will illustrate the present arrangement of the formations, and the movements to which they have been subjected.

IDEAL SECTION, ILLUSTRATING THE GEOLOGICAL STRUCTURE OF EAST TENNESSEE.*



T, A, B, The Cumberland Mountain, or Table-land. At T, the formations are horizontal; at A, they rise in a moderate fold, as at Crab Orchard, (§ 316;) at B is a more abrupt fold, which, by partial denudation, leaves a crest like that of Walden's Ridge, in the southern part of Roane, etc., (§ 331.) U, Unaka Mountain.

The broken or light portion of the section, occupying the depression, or the great valley between B and U, indicates the parts of the formations washed away, or, in other words, removed by denudation, after having been subjected to the movements of which we are speaking.

Including the dotted portions, the formations are represented as they were originally crowded up and *over* to the north-west in great folds, etc., thereby causing the strata, which compose them, to dip generally to the south-east.

At D, E, is a great fracture or slip, or what we have already termed a *dislocation* of the formations.

At H, L, is a similar dislocation.

The lines representing the formations as they now crop out in the Valley, are left unbroken. The low elevations within the depression are the Valley ridges, formed generally by sandstones, which more or less resist denudation.

At O is an *outlier* of the Unaka Group, formed by a fold of the hard sandstones of Formation III. Between this and U is a "Cove," formed by the partial removal of the softer rocks originally occupying the troughs of adjoining folds.

* Although we term this *ideal*, yet a *real* section, much like it, excepting that the dislocations are far more numerous, is presented by the formations from the Cumberland across through the northern part of Rhea, Meigs, McMinn, etc., to the mountains, separating us from North Carolina.

335. The feature most conspicuously illustrated by this section is the vast *folding* of the formations. The folds or great fluxures thus formed are seen to differ in magnitude: those of the Table-land are moderate in elevation; those of the Valley and the Eastern Mountains are thrown up and *over* to the *north-west* in enormous *plaits.**

336. Another feature illustrated is the *dislocation* of the formations. Two dislocations are introduced into the section—one between D and E, the other between H and L. In the first, the edge of a series of formations at D, broken off from the now depressed edge E, has been urged up and made to overlap the latter. The other has been similarly formed.

337. The formations typified in this diagram were once, doubtless, *horizontal*, and continuous over the whole Valley. (§ 298.) But by some amazing power, acting along a line parallel with our eastern border, and beyond it, they have been crowded to the north-west, relieving the immense lateral pressure, to which they have thus been subjected, by swelling up in great and long folds, or else, breaking along extended lines, slipping past and overlapping each other.†

338. Folds and dislocations thus formed, analogous to those the transverse sections of which we have just seen in the diagram, their summits and edges *now* more or less cut away by the denuding power of water, make up almost entirely East Tennessee.‡ They occur in

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* (a) *Sometimes*, in the eastern part of the Valley, folds of low elevation, etc., also occur. This more especially happens in the lee of some mountain ridge, or in the *bay* formed by its termination, the sandstone fold constituting it running out. Within such areas the rocks have been protected from the full force of the pressure from the south-east.

(b) In further illustration of this subject, refer to the sections on pages 33, 42, and the Map.

(c) In addition to the *greater folds*, multitudes of minor ones—which may comparatively be called *wrinkles*—occur in the strata comprising the former. Thus the formations are often extensively and deeply *corrugated* as they rise up in the folds, etc. These wrinkles are not indicated in the sections.

† This great pressure appears to have spent itself in the effects seen in the Sequatchee and Elk Fork Valleys.

‡ It is necessary to observe that the folds in the diagram have been purposely made

long parallel lines, in some cases a hundred miles and more in length, and are often arranged in *groups*.

339. Those of the Valley coming out of Georgia are at first limited in number, and run north a *few* degrees east; but advancing, they wheel around more and more to the east, receiving, occasionally, as the Valley widens, additional interpolated groups, until finally they enter the Valley of Virginia.* (§ 22–24.)

larger, in proportion to the length of the section, than they are in nature. We have done this, in order to bring out the folded and dislocated character of the country more clearly. For the same reasons, the number of folds, etc., represented, have been made less than would be met with in crossing any part of East Tennessee.

* East Tennessee is but a small part of a long and extensive system of parallel mountains and valleys, reaching from Alabama to Vermont, and having features analogous to those we have been describing. This is the great Appalachian or "Endless Mountain" system, including the Blue Ridge, the Alleghanies, etc.

To Professor W. B. Rogers, and his brother, Professor H. D. Rogers, is due the credit of having first *unfolded* its geological structure.

The time when this elevation of great ridges took place was soon after the deposition of the coal series, since all the formations from it downwards have partaken of the movement, while those above, or more recent, have not. The latter often rest in *horizontal* or nearly horizontal strata, upon the upturned edges of the former.

The physical and geological characteristics of East Tennessee are now easily accounted for.

1st. A striking one is the *parallelism* of valleys and ridges. (§ 22.) The direction of these conforms to that of the folds and dislocations. The strata, thrown up edgewise, and cropping out in bands of unequal hardness, have given direction to denudation. Along the lines of rocks easily removed by water, such as blue limestones and soft shales, the *valleys* have been washed out; but along those of sandstones, hard slates, and flinty limestones, *ridges* have been left. All the *mountain* ridges within the Valley are at least capped off with hard *sandstones*, which have protected the softer rocks below, and to which they owe their existence as ridges.

2d. The occasional vertical position, and the more general dipping of the rocks to the south-east, is accounted for. By the crowding of the folds *over* to the north-west, and the subsequent denudation of their summits, the strata have necessarily been left dipping, as we now find them.* It is, too, a necessary result of the overlapping of the formations, along the lines of fracture and dislocation, urged as they have been from the south-east. A glance at the section will at once explain these characters.

3d. The frequent *repetition* of the same formation, or rather *series* of formations, seen in crossing East Tennessee, is accounted for. This, also, is a necessary result of the peculiar structure developed. In traversing the edges of the formations, from the south-east to the north-west, a very great variety of such series is observed.

In the first place, crossing the denuded *summit* of a *fold*, we pass successively from

* When the *summit* of a fold is cut by the surface, the rocks on each side may dip in opposite directions, etc., etc.

3d. *Metamorphism.*

340. So far, we have spoken of the *physical* changes to which the formations have been subjected.

There is, beside, another change, of a chemical nature, and affecting the component parts of the rocks, which has taken place in the strata of the first two oldest Tennessee groups. These strata were once, most likely, common sandstones, conglomerates, slates, shales, etc.—mere indurated *mechanical* mixtures of sand and mud—like those of the other formations; but through the action of heat, it may be, though retaining their stratified character, they have since assumed a different texture. The elements of the sand and mud have been converted into well-defined minerals, occurring generally in crystalline grains, and changing very materially the aspect of the rocks which they compose.

341. Such change is called *metamorphism*, and rocks thus changed are said to be *metamorphic.**

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newer to older formations, until we reach the turning line, or axis; then the order is reversed. Representing the formations by their numbers, as given in the table at the end of this chapter, and the axes of folds by a dot, the series generally thus passed over will be indicated by combinations like the following: 9, 8, 7, 6, 5, 4,·4, 5, 6, 7, 8, 9; 6, 5, 4,·4, 5, 6, 7; 7, 6, 5,·5, 6, 7, 8, etc., etc. The absence of corresponding numbers from one side in most of them, is in part due to the interference of dislocations.

In crossing a *trough*, or concave flexure between two folds, the order is likewise reversed, but the upper or newer formations are nearest the axis, as follows: 1, 2, 3, 4,· 4, 3, 2; 4, 5, 6,·6, 5, 4, 3, etc., etc.

If we traverse a *dislocation*, a *part* or the whole of the series is repeated in the *same* order or succession. Representing the line of displacement by a hyphen, such series may be thus indicated: 7, 6, 5, 4,-7, 6, 5, 4; 9, 8, 7, 6, 5, 4,-6, 5, 4; 4, 3,-6, 7, 5, 4, 3, etc., etc. Combinations of these different classes, in great variety, are presented in nature.

The section on page 42 will serve to illustrate what we have said. Between A and C, we have a denuded fold of low elevation, the formations of which, commencing at C, present the following series: 6, 5, 4,·4, 5, 6, 7, 8, 9, 10. Between H and C, there are no less than three dislocations, exhibiting, commencing at H, the following combined sets of series: 4,-9, 8, 7, 6,-9, 8, 7, 6, 5, 4,-6, 5, 4. Such is the arrangement of the formations observed in crossing this portion of Hancock and Claiborne.

* Some of the most common *metamorphic* rocks are:

1st. *Gneiss.*—This is a hard crystalline and more or less stratified rock, composed, generally, of three minerals, in variable proportions, called by mineralogists *quartz*, *feldspar*, and *mica*. Sometimes another mineral, *hornblende*, replaces the mica, or is

In our first formation this change is complete, and the rocks are truly metamorphic; in the second, it is partial, many strata, and especially the conglomerate, retaining in part their mechanical structure.

342. This concludes our brief and imperfect sketch of the geological structure of Tennessee. We have been led to notice, and but *partially* notice, the extent and origin of the great groups which compose it, and the mighty movements and changes to which they have been and, in part, are subjected.

There is no lack of "wonders" in the Geology of Tennessee, to instruct and fill us with admiration. We need not go beyond her limits to find astounding evidences of the wisdom and omnipotent power of the Great Creator, who unceasingly controls and directs the works of his hands.

> "My heart is awed within me, when I think
> Of the great miracle which still goes on
> In silence round me—the perpetual work
> Of Thy creation, finished, yet renewed
> For ever!"

We close this chapter with a table of our geological formations as provisionally adopted for the purposes of the Survey. This classification is, however, in the main, natural, and will not admit of many changes. The table includes conspicuous examples or members of the formations, together with a column indicating the part or parts of the State in which the latter are developed, and another giving the names of equivalent groups, etc., used by geologists.

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superadded to it, constituting a *syenitic* gneiss, etc. We apply the term *gneissoid* to rocks which are associated with and resemble gneiss. Granite is like gneiss in composition, but differs in not being *stratified*.

2d. *Mica Slate.*—This, as its name implies, is a slaty rock; it is composed essentially of mica and quartz.

3d. *Hornblende Slate.*—This is generally a black or dark gray slaty rock, composed of hornblende, with more or less feldspar and quartz.

4th. *Chlorite* and *Talcose Slates.*—These are often greenish (especially the former) slaty rocks, characterized respectively by soft minerals, called *chlorite* and *talc*.

5th. *Clay Slate.*—This resembles indurated clay or shale, and often affords roofing-slate, etc., etc.

TABLE OF THE GEOLOGICAL FORMATIONS OF TENNESSEE,

Commencing with the lowest, or oldest, and ascending, or, in other words, arranged according to the ascending scale.

TENNESSEE NAMES.	EXAMPLES.	IN WHAT DIVISION OF THE STATE DEVELOPED.			NAMES OF GROUPS, CLASSES, SYSTEMS, ETC., USED BY GEOLOGISTS.		
14. Alluvial Series.	2. "Bottoms" of the Mississippi. 1. Alluvial Bottoms of all the Streams, and the Gravel-beds of their Channels, etc.	East.	Mid.	West.	Alluvial or Recent.	Post-Tertiary.	Post-Tertiary.
13. The Bluff and Drift Series.	3. Upper part of the Mississippi Bluffs. 2. The high Gravel-beds in the vicinity of the East Tennessee Rivers. 1. The Gravel-beds of Hardin, Wayne, ? etc.	East.	Mid.	West.	Post-Pliocene.		
12. Lignite Group.	1. Lower part of the Mississippi Bluffs—composed of Sands, Laminated Clays, and beds of Lignite, etc.	....	....	West.		Tertiary. ?	Tertiary. ?
11. Orange Sand Group.	4. The Red Ferruginous Sandstone of the District. 3. The Yellow and Orange Sands and Stratified Clays of the Central part of the District. 2. The Green Sand of McNairy, etc. 1. The Clays and Sands of Chalk-Bluff, in Hardin.	....	....	West.	Cretaceous.	Cretaceous.	Secondary.
10. Coal Measures.	1. Shales, Sandstones, and Coal, of the Cumberland Table-land.	East.	Mid.	....	Coal Measures.	Carboniferous System.	Primary, Fossiliferous, or Palæozoic.
9. Mountain Limestone.	3. Limestone of the Escarpments of the Cumberland Table-land. 2. Limestone of Newman's Ridge, Lookout Mountain, etc. 1. Upper Limestones of Montgomery, Dickson, etc.	East.	Mid.	....	Carboniferous, or Pentremital Limestone.		

8. Siliceous Group.	3. Calcareo-siliceous and Flinty Rocks of the Highland Rim of Middle Tennessee. 2. Sandstones of Stone and Pine Mountains, in Hawkins. 1. Sandstones in front of Montvale Springs.	East.	Mid.	West.	Lower Carboniferous Series.	Carboniferous System.	Primary, Fossiliferous, or Palæozoic.
7. Black Slate.	3. Black Slate along the eastern base of Clinch Mountain, etc. 2. Slate of the Highlands of Central Middle Tennessee. 1. Black Slate of the Tennessee River Valley, west.	East.	Mid.	West.	Bituminous, or Aluminous Slate, Olive Shale, etc.	Carboniferous System.	Primary, Fossiliferous, or Palæozoic.
6. Dyestone and Gray Limestone Group.	4. Limestones of the Harpeth and Tennessee Rivers, west. 3. Limestone of Sneedville. 2. Shales, thin Sandstones and Dyestone of the base of the Cumberland, etc., East Tennessee. 1. Sandstones of Clinch and Powell's Mountains.	East.	Mid.	West.	Helderberg Series, Cliff Limestone, Niagara Limestone, Clinton Group, Gray Sandstone.	Devonian, and Upper Silurian Systems.	Primary, Fossiliferous, or Palæozoic.
5. Central Limestone and Shale Group.	5. Calcareous Shales of Bay's Mountain, etc. 4. Red Sandy Limestone of the Knobs in Monroe, McMinn, etc. 3. Beds of Variegated and Gray Marble in Hawkins, Knox, etc. 2. Blue Shelly-Limestone of many Valleys in East Tennessee. 1. Blue Limestone of the Central Basin, Middle Tennessee.	East.	Mid.	....	Hudson River Group, Trenton Limestone, Black River Limestones.	Lower Silurian System.	Primary, Fossiliferous, or Palæozoic.
4. Magnesian Limest'ne and Shale Group.	3. Limestone of Knoxville. 2. Limestones and Variegated Shales of numerous Valleys and Ridges in East Tennessee. 1. Thin-bedded and many-colored Sandstones of numerous Sharp Ridges in East Tennessee.	East.	....	....	Calciferous Sandstone.	Cambrian System.?	Primary, Fossiliferous, or Palæozoic.
3. Chilhowee Sandst'nes and Shales.	2. Quartzose Sandstones of Chilhowee, of the French Broad River, etc., etc. 1. Sandstones and Sandy Shales of Paint Mountain, etc.	East.	....	....	Lower beds of the Upper Mississippi. Potsdam Sandstone.	Cambrian System.?	Primary, Fossiliferous, or Palæozoic.
2. Ocoee Conglomerates and Slates.	3. Conglomerates and Slates of the Ocoee River. 2. Semi-talcose Slates of Monroe, Blount, etc. 1. Conglomerate and Slates of the French Broad, and of the Mountains in Sevier.	East.	....	....	Semi-metamorphic Series.	Azoic.	Metamorphic.
1. Mica Slate Group.	2. Mica Slates of Ducktown. 1. Gneissoid Rocks of Washington, Carter, and Johnson, etc.	East.	....	....	Metamorphic Rocks.	Azoic.	Metamorphic.

CHAPTER VI.

NOTICES OF THE GEOLOGICAL FORMATIONS OF TENNESSEE.

343. WE had intended to give in this chapter more complete and systematic descriptions of our formations than is now subjoined, but our manuscript has already exceeded the length we had assigned it; and, in addition, the time allowed us for preparing the Report is now very limited, and compels us to be brief.*

344. The following notices, introductory to the more complete descriptions, is but little more than an expansion of the table given at the close of the last chapter.

SECTION I.

METAMORPHIC ROCKS.†

345. The first two of our formations, commencing with the *oldest*, may be included under this head. The *first* has a well-marked metamorphic character; the *second* is semi-metamorphic.

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* The making out of the formations, and their clear presentation, constitute the foundation, and the only foundation, of a thorough and practical geological survey.—(§§ 7 and 13.) With a view to this fact, the arrangement we shall adopt in our next Report will be very different from that *necessarily* followed in this. The formations themselves will be made throughout the basis of classification. The description of each one, as far as made out, will constitute the subject of a chapter. This description will refer to *the extent and range* of the formation: its *lithological characters:* its *physical features:* its *palæontology:* its *useful ores, minerals, and rocky products:* its *agricultural characters*, etc.; each subdivision, perhaps, constituting the subject of a distinct section.

† For the definition of metamorphism, metamorphic, etc., see paragraphs 340 and 341.

(1st.) *Formation I.—The Mica Slate Group.*

346. The line separating us from North Carolina coincides nearly with that which separates the strata of this group—the true *Mica Slates* and *Gneissoid Rocks* (§ 341)—from those of Formation II. They reach over, however, and constitute several areas of considerable extent in Tennessee, which are indicated upon the map.*

Of these, the Ducktown area, (§ 98,) and the greater one in Washington, Carter and Johnson, are the most extensive and important. In the former, mica slates prevail; in the latter, gneissoid rocks—many of them syenitic—with occasionally mica slates. (See also §§ 106 and 118.)

347. Valuable products are and may be furnished by this formation.† (See §§ 61, 107–112, 117, 118, and 268.)

(2d.) *Formation II.—The Ocoee Conglomerates and Slates.*

348. The rocks of this formation are grandly exposed along the *narrows* of the *Ocoee*, and hence the name of the group. (See §§ 106 and 99.) It is a very heavy formation, many thousand feet in thickness, and constitutes most of the mountain parts of Polk, Monroe, Blount, Sevier, and Cocke. (See Map.)

North of the French Broad it is by no means as abundant. Narrow bands, comparatively, are occasionally met with, but the sandstones of Formation III., and the rocks of the Mica Slate Group, constitute mostly the northern mountain ranges.

349. The rocks of this group are coarse, gray conglomerates and talcose, chlorite and clay slates, all repeatedly interstratified, and generally dipping at a high angle to the south-east. The conglomerate abounds in quartz and feldspar pebbles; occasionally it is sandstone.

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* In addition to the metamorphic rocks along the line, there is a very curious and narrow strip of soft talcose and micaceous slate, affording steatite, chlorite, and fine crystals of magnetite, in Claiborne and Campbell, near Clinch River. This strip lies in the line of a great dislocation, and separates Formations VII. and VIII. from Formation IV.

† For *physical and agricultural features*, see note on page 153.

The slates are generally greenish, though dark purplish clay slates are met with; the talcose and chlorite varieties mostly prevail.

At some points the slates have a fine semi-micaceous character approaching mica slate, (§ 144,) and now and then extensive tracts are found without the alternate bands of conglomerate.

In some regions strips of slaty limestone and breccia marble (§ 216) —belonging, perhaps, to the lower part of Formation IV.—are involved in the foldings of the slates and conglomerates of this great group.

350. The products of this formation are of much interest.* (See §§ 135–144; 119; 243–246; 269–272, etc.)

SECTION II.

THE CAMBRIAN SYSTEM.

351. We use the term Cambrian† *provisionally*, to unite our first two *fossil-bearing* formations. Formation IV. *appears* to have characters which separate it from that immediately above, but whether sufficiently to justify the placing of it in a distinct system is doubtful. For the present, however, this arrangement suits our purposes.

(1st.) *Formation III.—The Chilhowee Sandstones and Shales.*

352. This is a great group of dark gray micaceous, sandy shales and sandstones, and grayish-white quartzose layers, altogether several thousand feet in thickness.

It is the characteristic formation of the outliers, and the extreme western ranges of the Unaka Bed of Mountains.‡ (See §§ 18, 19, and

* For *physical and agricultural features*, refer to note on page 153.

† This term, Cambrian or Cumbrian, is used more or less by English geologists to designate the oldest fossiliferous strata developed in Cumberland, etc.

‡ It does not, however, *always* occur in its place, being absent by dislocation.

Of many really *grand* sections of these rocks exposed along some of the rivers which cut the Unaka bed, (§ 18,) none is more so than that exhibited on the French Broad, commencing at the "Painted Rock," on the line, and extending a mile or two down the river.

Map.) *Chilhowee* Mountain, in Sevier and Blount, is composed of these rocks, and gives name to the group.*

353. Near the upper part of the formation, more or less in all the Unaka counties, heavy beds of grayish-white quartzose sandstone occur, which are generally freely pierced by the peculiar rod-like fossil† (*Scolithus linearis*) of the New York Potsdam Sandstone.

(2*d*.) *Formation IV.—The Magnesian Limestone and Shale Group.*

354. This extensive formation—several thousand feet in thickness—pervades the greater part of the Valley of East Tennessee. It is a great series of sandstones, shales, and calcareous strata, but containing throughout more or less magnesian limestone.

355. It consists of three members, or subordinate groups, as follows:

1. *The Sandstone Member.*—This—the lowest sub-group, many hundred feet in thickness—is made up mostly of brownish-red, sometimes pale greenish, smooth fine thin sandstones, abounding in *fucoidal* remains,‡ and occasionally approaching slate in character. The lower part of these thin sandstones, or slates, generally includes heavier layers of gray and variously colored sandstones, some of which are dark, others lighter with green points; some, too, fine-grained, others coarse and gritty. Occasionally, bands of dark gray magnesian limestone, and at some points calcareous slates, occur interstratified with the sandy layers. The hard sandstones of this member form many sharp, straight, roof-like, or "comby" *ridges* in East Tenenssee.

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* The *physical* and *agricultural* features of the first three formations may be considered together.

They are preëminently the formations of the eastern mountains. (§ 18.) The hard rocks of all of them form bold ridges; some of the softer slates have been hollowed out in shallow basins and troughs, which nevertheless are generally high above the Valley of East Tennessee. (§§ 98, 138, 144, etc.)

Formation III., in general, forms the *outliers*, by running up through the calcareous rocks and shales once resting horizontally upon it, and thus cuts off the limestone *coves* from the greater Valley to the west.

Some of the mountain ranges are very rough, but generally they are rounded, covered with open woods, and often have gently rolling summits, which afford good soil, and are well adapted for excellent highland pasture-grounds. (See § 20.)

Herds of cattle, mules, horses, etc., by thousands, are already kept and *fattened* upon them. Such animals delight in the freedom and rich food of these regions, and require but little attention beyond that of an occasional "*salting*."

† Specimens of this fossil, occurring as long straight sandstone rods, from one-eighth to three-eighths of an inch in diameter, may be found abundantly in the vicinity of Montvale Springs.

‡ Or remains of sea-weeds.

2. *The Shale Member.*—This is a heavy sub-group—many hundred feet thick—of brownish-red, greenish, and buff, or variegated soft slates or shales. It often contains seams and beds of blue *oölitic* limestone, *abounding* in the remains of *Trilobites.** At some points the shales themselves furnish *Trilobites*, as well as *Lingulæ.*† This member occupies numerous *valleys*, many of them rich and fertile, in East Tennessee. Its superior part, interstratified with the blue *oölitic* and *Trilobite* limestone, gradnally runs into the upper and following division.
3. *The Limestone Member.*—This, too, is a heavy sub-group—perhaps not less than a thousand feet in thickness. It is generally heavy-bedded limestone throughout; the lower part is *blue*, often *oölitic*, and frequently *striped* with argillaceous seams; the middle strata are usually *dark gray*, more or less sparry, and magnesian ; the upper, gray *cherty* and likewise magnesian. Such at least is its typical character; at some points these subdivisions are not easily recognized. Knoxville is mostly located on the upper portion, and interesting sections are exposed within the limits of the city. Many of the *rounded cherty ridges* of East Tennessee are composed of the same rocks.

356. We have had already frequent occasion to refer to the useful products of this formation. (See §§ 59, 65,‡ 69, 122, 130, 213, 214, 263, etc.)

SECTION III.

THE SILURIAN AND DEVONIAN SYSTEMS.

357. The strata included in this section—all of which are fossil-bearing—are mostly limestones and calcareous shales. The series includes, in addition, the dyestone iron ore, and a well-defined stratum of gray sandstone.

(1st.) *Formation V.—The Central Limestone and Shale Group.*

358. The rocks of this formation belong to the *Lower Silurian*§ system of geologists.

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* An *extinct* family of marine animals, in some respects allied to crabs, lobsters, etc.

† A genus of small, thin, and often tongue-shaped sea-shells.

‡ We have *recently* been informed that there is an old forge in Knox. It has, however, done little or nothing within several years past, and is not included in the table of forges.

§ This term has been derived from *Silures*, the name of a tribe of ancient Britons. The rocks, which occupy the region formerly inhabited by them, when first made out, were grouped together in a system which, in consequence of historical associations, was called *Silurian*. Our Formation V. occupies a corresponding place in the geological series, and hence must be referred to the same system.

The entire area within the *Central Basin* of Middle Tennessee (see §§ 35, 36, and Map) is occupied by nearly horizontal strata of *blue limestones*, in all, perhaps, from 800 to 900 feet in thickness,* which belong to this formation.

They are easily divided into two nearly equal members, which we have called, respectively, commencing with the lower, the *Stones River* and *Nashville* sub-groups.

1. The *Stones River*, or lower member, is a series of blue and dove-colored limestones, more or less cherty, not generally as argillaceous as those of the succeeding member, and often remaining thick-bedded when weathered; it contains, however, several thin-bedded argillaceous divisions.
2. The *Nashville Member* is blue argillaceous, more or less sandy, compact, and highly fossiliferous limestone, weathering, generally, into thin-bedded rough layers, often separated by seams of shaly matter.

   The marble of Franklin (§§ 192, 200) is a local stratum in the topmost part of this member.

359. These two sub-groups are distinctly separated by fossiliferous characters. The first is equivalent, generally, to the Black River Groups and Lower Trenton, and the second to the Hudson River Group, Utica Slate, and Upper Trenton, of New York.

360. In the *eastern portion* of the *Valley of East Tennessee*, the corresponding rocks swell out to double, or perhaps to more than double the thickness they have in the Central Basin.

Here, too, they may be divided, generally, into two sub-groups, of which the *Stones River* and *Nashville* are the western extensions.

1. The *Lower Sub-group*—five or six hundred feet thick—is a bed of blue, often knotty or *spumose*, limestone, containing many fossil shells of species (*Maclurea magna*, *Orthis deflecta*,† etc.,) identical with those found in the Stones River sub-group. This division following Formation IV., is often, in its lower part, interstratified with the gray magnesian limestone.
2. The *Upper Sub-group* is mostly a vast bed of calcareous, and more or less sandy shales. These are developed on a great scale in the Bay's Mountain Ridges. (§ 24.) They include, occasionally, thin layers of sandstone, and are generally

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* See, also, "Silurian Basin of Middle Tennessee."—American Journal of Science and Arts, vol. xii., 2d series.

The thickness of these rocks is given, in that paper, at about five hundred feet. Since it was written, other lower beds, etc., have been discovered.

† The so-called *Leptæna deflecta* is a true *Orthis*, and characteristic of the lower member of our Lower Silurian rocks.

highly calcareous, having a sky-blue, rarely a dark-gray color, and weathering to a sandy gray or yellowish-gray, or, when more argillaceous, to a buff surface. The lower portion, especially in Sullivan and Greene, affords fine dark, or even black, argillaceous shales, which form long and frequently isolated "slate ridges." The topmost portion in Hawkins is often reddish.

A great band of these calcareous shales extends from the group of mountains mentioned above, down through Jefferson, Sevier, Blount, etc., becoming, however, less important in its southern extension.

The most characteristic *fossils* are the linear serrated corals, called *Graptolitidæ* by geologists. They occur (both *Graptolites* and *Diplograpsus*) nearly at all points.

Among the shaly strata of this sub-group, especially in its lower portion, are several extensive *interpolated* beds, which have their maximum development in different parts of East Tennessee. The most important are the following:

(*a*) The *gray marble*, already spoken of, (§ 209, etc.,) which lies at the base of the sub-group.

(*b*) The *variegated marble*, of which, too, we have spoken. (§§ 195, 197, 199, etc.)

(*c*) A dark gray, very *ferruginous* sandy limestone, with a red *streak*,* and weathering into red ferruginous sandy and often porous masses. This bed, sometimes represented by many parallel ranges, commencing in Jefferson and Knox, extends to the Hiwassee, in the south-eastern part of McMinn. It is heavily developed in Blount, Monroe, and McMinn, forming the red sandy "knobs" of those counties.

These beds are separated by shales, etc. Hereafter we shall present complete sections of them.

361. Passing westward, tho shales of the upper sub-group *rapidly* run into thin-bedded, argillaceous limestones, which, in the narrow valleys of the *western portion* of the *Valley of East Tennessee*, are much like those of the Nashville series.

(2*d*.) *Formation VI.—The Dyestone and Gray Limestone Group.*

362. This is a *protean* group, provisionally adopted to include several distinct formations. We apply in part the term *dyestone* to it, on account of the presence of this interesting iron ore among the strata of one of its divisions. (§ 67.) Its rocks belong to both the Upper Silurian and Devonian† systems of geologists.

363. In East Tennessee it is a group of *sandstones*, *calcareous*

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* Red when scratched or pulverized.

† The term *Devonian*, like *Silurian*, is of English origin. Characteristic rocks of this system are well developed, and were early studied, in South *Devon*, England, and hence the name.

shales, including *dyestone*, and some *limestone;* in Middle and West Tennessee, it is almost entirely *limestone.*

In the former Division, the following sub-groups occur:

The Clinch Mountain Sandstone.—This, several hundred feet in thickness, is a light gray, generally thick-bedded sandstone, abounding at many points in *fucoids.* It sometimes affords layers of conglomerate, the pebbles like small peas in size. The upper part at some points, in Hancock especially, is red and highly *ferruginous.*

This sandstone is the great *protecting* rock of many high ridges in northern East Tennessee; it caps, and, in most cases, rests against the south-eastern side of the Bay's Mountain ridges, the Devil's Nose, etc., in Hawkins, Clinch Mountain, Newman's Ridge, Powell's Mountain, etc. (See § 24, and note, page 145.)

Its greatest development is perhaps in Clinch Mountain. In southern East Tennessee, it is unimportant, and rarely seen.

2. *Shales, thin fine Sandstones, and Iron Ore.*—This member, two or three hundred feet thick at some points, is composed of variegated shales, often calcareous, and including thin layers of brown and gray fine sandstones, often beautifully ripple-marked.

The dyestone is imbedded in the shales, and generally occurs in one or two layers, etc. (See also §§ 67–75.) All these strata contain organic remains.*

3. *Sneedville Limestone.*—At Sneedville, and several other points in Hancock and Claiborne, a band of gray limestone, which perhaps will be found to be from one to two hundred feet in thickness, rests upon the last member. It occasionally affords interesting beds of fossil corals.†

364. In *Middle and West Tennessee,* this formation is almost wholly gray, or bluish-gray, limestone. Some of its strata are blue, others reddish, and many of them argillaceous.

It is wanting along the eastern slope of the Central Basin, but appears again along its western and north-western sides. (See note, page 132.) It is here generally less than fifty feet in thickness, though sometimes more. Going westward, it thickens rapidly, and, becoming several hundred feet thick in Hardin, Decatur, etc., occupies the valley of the Tennessee in those counties.

365. Its lowest member is the hydraulic limestone of which we have spoken.‡ (See § 259.) It affords, too, the marble of Henry, Benton, etc. (See §§ 191 and 200.)

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* We have observed *Crinoids, Trilobites, Orthocerata,* etc., etc. *Strophomena depressa* has been seen, and *Bryozoa* abound in the dyestone.

† Among these corals are *Favosites, Halysites catenulatus,* or the "chain-coral," formerly called *Catenipora escharoides,* etc.

‡ This bed may possibly belong to Formation V.

Most of its strata are well charged with fossils, respectively of Upper Silurian and Devonian types.

SECTION IV.

THE CARBONIFEROUS SYSTEM.

366. The group of formations included in this section constitute the *Carboniferous System* of Tennessee, so called from the fact that one of them is the great repository of our stone coal.*

(1*st.*) *Formation VII.—The Black Slate.*

367. We have had frequent occasion to refer to this remarkable formation. It is a brownish-black slate, often pyritiferous and bituminous. Its average thickness in Tennessee does not reach one hundred feet. In northern East Tennessee it swells out to more than this; toward the west and south-west, however, it gradually grows thinner.† In Wayne and Hardin it is sometimes but two or three feet thick, and is in part replaced by a dark gray more or less bituminous sandstone, from five to twelve feet in thickness.

It affords, at many points, fossil *Lingulæ*. (See note, page 154.) We have also seen specimens of a *Chonetes* in it.

(See also, in addition, §§ 9, 242, 252, 294.)

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* There is some doubt as to whether the first of the group—the Black Slate—is Carboniferous or Devonian.

† We are under especial obligations to Mr. William Echols Hollowell, of Huntsville, Alabama, for mnch valuable information in regard to the geology of Jackson, Madison, and Limestone counties, Alabama. We regret that our limits will not permit us to introduce all the facts with which he has furnished us, so far at least as they bear upon the geology of Tennessee.

Among other sections, the following is one taken by Mr. Hollowell on Hester's Creek, in Madison county, near the Tennessee line.

(*a*) Siliceous group.
(*b*) Black Slate; upper part containing much pyrites; lower part abounding in Lingulæ. Thickness, twenty feet.
(*c*) Mottled pink limestone, containing pyrites—eight feet.
(*d*) Dove-colored shale—twelve feet.
(*e*) Blue limestone, very fossiliferous in the bed of the creek—six feet.

(2d.) *Formation VIII.—The Siliceous Group.*

368. In *East Tennessee*, east of the Cumberland, this formation is mostly sandy shales and sandstone, generally thin-bedded, and sometimes affording flagging materials, altogether many hundred feet in thickness. Ranges of it occur in Blount, etc., near and in front of Chilhowee,* in Grainger and Hawkins, east of Clinch Mountain, and constituting, in part, Stone Mountain, etc.

Passing westward, the formation loses more and more its sandstone character.

369. In *Middle Tennessee* it is generally a light-blue, fine-grained, heavy-bedded, (occasionally shaly,) rock, from two to three hundred feet in thickness, constituted of a heavy siliceous skeleton, charged more or less with calcareous matter, and containing layers of hornstone or flint. It is generally *dotted* with siliceous—sometimes calcareous concretions—and at several points affords fine geodes of quartz. It weathers into a yellowish—sometimes bluish—sandy shale. Southward, it becomes more calcareous, and often contains beds of cherty limestone.

370. Intercalated and interesting beds of grayish-white *crinoidal* limestone occur, generally among the lower strata, at many points throughout Middle Tennessee.

It is the topmost group of the escarpment, all around the Central Basin, and forms the characteristic flinty "barrens." (§ 34.) Along the Tennessee River, west, it is also the uppermost rock of the hills, back from the river, etc.†

Large *Spirifers*, *Producti*, *Crinoids*, and many other Carboniferous fossils, are often seen in it.

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* An interesting section of rocks is exposed in the vicinity of Montvale Springs. Starting from Chilhowee, we have, first, the sandstone of Formation III.; (see page 152;) then follows a band of Carboniferous or Mountain limestones, containing characteristic fossils; then the shales and sandstones of the Siliceous Group; then the Black Slate, etc.

It will not be surprising if limited patches of the Coal Measures be found near Chilhowee. It is possible, too, that beds of gypsum may be found in this range of Carboniferous rocks.

† A friend, whom we highly esteem, both for his excellent social qualities and his

(3d.) *Formation IX.—The Mountain Limestone.*

371. This formation is mostly a great series of blue and light-blue, thick-bedded, and, in great part, oölitic limestones, between ten and twelve hundred feet in thickness. It constitutes the base of the Cumberland Table-land, (§ 26,) and, excepting a few points on the East Tennessee side, crops out all along the lower part of its escarpments on both sides. It appears on both sides of Sequatchee Valley, forms the base of Pine Mountain of the Elk Fork, (§ 325,) etc.

Its greatest presentation is along the western escarpment, from

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scientific attainments, Professor Thomas P. Hatch, of Lagrange College, at Florence, Alabama, has furnished us with much valuable information in regard to that part of Alabama included between the Tennessee and Elk rivers and the Tennessee line. Professor H. has made a reconnoissance of this whole region.

The Siliceous Group, as we term it, is found to pervade almost the entire area, the strata dipping gently south and west. In the middle and eastern portion of the northern half of the region, two or three of the lower groups are generally brought up and exposed in the narrow valleys of the Elk and other streams which cross the Tennessee line. The following is a *general* section of the strata, etc., of this part of Alabama, made out by Professor Hatch.

FORMATIONS.	THICKNESS IN FEET.	CHARACTER OF STRATA, ETC.
XIII.	?	(*a*) Beds of ferruginous coarse conglomerate and gravel, overlying the other formations in the western part of Lauderdale.
VIII.	203	(*b*) A reddish and yellowish earthy and siliceous rock; same, perhaps, as c, but weathered. Best developed in the southern part of Lauderdale, etc. Thickness about twenty-five feet. (*c*) A bluish, highly siliceous or flinty rock, more or less calcareous—sixty feet. (*d*) Bluish siliceous shale—eight feet. (*e*) A heavy bed of gray *crinoidal* limestone, containing occasionally thin seams or patches of flint—one hundred and ten feet.
VII.	6 to 8	(*f*) Black bituminous slate, interstratified with sandstone, both affording *Lingulæ*.
VI.	58	(*g*) Bluish gray calcareous sandstone—eight feet. (*h*) Gray limestone—fifty feet.
V.		(*i*) Dark blue argillaceous limestone in the beds of the Elk and several creeks crossing the Tennessee line.

which the lower strata spread out, generally some distance over the Highland Rim.* (See § 31–34, and Map.)

372. Its lower strata are cherty limestone, yielding a reddish soil. Its topmost strata mostly are highly argillaceous limestones, weathering into variegated shales. Near its middle, all along the western slope of the Cumberland, from Kentucky to Alabama, is a band of sandstone from fifty to a hundred feet in thickness.

It abounds in carboniferous fossils. *Pentremites* (*florealis* and *pyriformis*) are found almost throughout its entire thickness.

(4th.) *Formation X.—The Coal Measures.*

373. The *Coal Measures* consist of alternating beds of sandy conglomerates, sandstones, shales, and coal. There are, in addition, two or three local thin and unimportant beds of limestone.

This group constitutes the upper portion of the Cumberland Tableland.

We have already had frequent occasion to refer to it, and will at present add nothing more. (See §§ 26–34; 160–178; 290; 313, etc.)

SECTION V.

THE CRETACEOUS SYSTEM.

374. The strata referred to this system are confined exclusively to West Tennessee, and are included in the formation below, the range and extent of which are approximatively given upon the Map. (See §§ 296, 298, 303, and 304.)

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* Isolated bands of this limestone occur in Monroe, near Chilhowee, (see note on page 159,) in Hawkins, east of Clinch Mountain, and separated from it by the Black Slate and Siliceous Group, in Hancock, east of Sneedville, and in Newman's Ridge, in Bradley and Hamilton, east of White Oak Mountain. It constitutes the base of Lookout Mountain, and the other outliers of the Cumberland.

Extensive patches occur in Montgomery and Dickson, and on the Highlands of Hickman, Wayne, Lawrence, etc. (§ 87.)

Formation XI.—The Orange Sand Group.

375. This is a heavy group of sands and clays, generally but little indurated, and including a bed of "green-sand." It is apparently divisible into the following members, commencing with the lowest:—

1. *A series* of grayish-white and yellowish sands and laminated clays, containing often seams of lignite and half-carbonized woody matter—from one to two hundred feet exposed at "Chalk Bluff," in Hardin.
2. *Green-sand*, of which we have spoken. (See §§ 221–228.)
3. *A series*, several hundred feet thick, of heavy beds of *orange*, yellow, and white sands, interstratified with laminated clays, which are dark when wet, but sometimes become gray and loamy when dry and exposed. Beds of white potter's clay occasionally occur.

   Most of the high points are capped off with red ferruginous sandstone. This member covers the greater part of the District. (See § 88.)

376. We have many facts bearing upon the geology and agricultural features of this interesting formation, which, being necessarily deferred, will be incorporated with the results of future observations in our next report.

SECTION VI.

TERTIARY AND POST-TERTIARY (OR QUARTERNARY) SYSTEMS.

377. This section includes the remaining and mostly superficial formations of Tennessee. It is a group of clays, beds of lignite, sands, loam, gravel, alluvial deposits, soils, etc., to which, for many reasons, great interest is attached. During the time of the deposition of some of these upper strata, the Megalonyx, and the great Mastodon and Mammoth, the remains of which are now found at many points, flourished in the Valley of the Mississippi.

(1*st*.) *Formation XII.—The Lignite Group—(Tertiary ?)*

378. For the *present* we have included certain strata, and among them the *lignite series* of the Mississippi Bluff, (see section, page 102,) in this group.

It is most likely that our future observations will lead us to include the latter series in the superior formation, and perhaps to unite all the strata of the Bluff in a single group.

We have, in fact, not as yet met with any *characteristic* Tertiary strata. There appears to be a great *gap* between the Bluff series and the Cretaceous formation. Our attention will be directed particularly to such intermediate beds as may exist.*

(2d.) *Formation XIII.—The Bluff and Drift Series—(Post-Tertiary.)*

379. We include in this group the upper part of the Mississippi Bluff, and many superficial gravel-beds in the State, the origin of which cannot be referred to any existing cause. The following are the most important members:—

1. The *Middle Part* of the Mississippi Bluff, composed of gravel, sands, and clays. See "Gravel Series" in the section on page 102.
   As we have already said, the "lignite series" ought perhaps to be associated with this.
2. The *Loam Beds*, or *Bed*, or the upper part of the Mississippi Bluff. This is a most interesting stratum of light-yellowish ashen earth or loam. See section on page 102 and paragraph 39. We have not had, as yet, an opportunity of ascertaining its average thickness. It is less, perhaps, than one hundred feet.
3. The *Superficial Gravel-beds* of Wayne, Hardin, and adjoining counties. Beds of coarse and often ferruginous gravel, or conglomerate, are frequently found in these counties overlying the other formations.
4. *Beds of Gravel* and large pebbles are frequently met with on elevated hills, far above high-water mark, along several of the East Tennessee rivers, especially those which break through the Unaka Group. These beds are found frequently several miles from the rivers, and thirty or fifty from the Unaka Mountains. The pebbles are often quartzose and occasionally contain the rod-like fossil (*Scolithus linearis*) of which we have spoken. (§ 353.)

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* In paragraph 305, we have spoken of the elevation of the land, and the retiring of the sea-arm, from which were deposited the Cretaceous strata, (and it may be some Eocene beds,) as if they had taken place uniformly without depressions, etc. It is, however, necessary to observe that the strata of the Bluff Series, etc., may not be conformable to those of Cretaceous age; in which case there might have been first an elevation, followed by the complete retiring of the sea, and afterwards a depression, followed by the lake-like expansion of the Mississippi, etc., or there might have been a series of such elevations, depressions, etc.

(3*d*.) *Formation XIV.—The Alluvial Series—(Post-Tertiary.)*

380. This group, finally, includes all stratified beds of alluvial matter, sands, gravel, clays, etc., which have been formed by existing causes—mostly by our rivers.

The Mississippi bottoms (see page 30) afford by far the largest area of an alluvial, or rather series of alluvial deposits, in the State. (§ 308.) Next to those of the Mississippi, the bottoms of the Tennessee River, west, cover, in the aggregate, the largest area. But we cannot specify further. Nearly all our rivers furnish deposits referable to this group.